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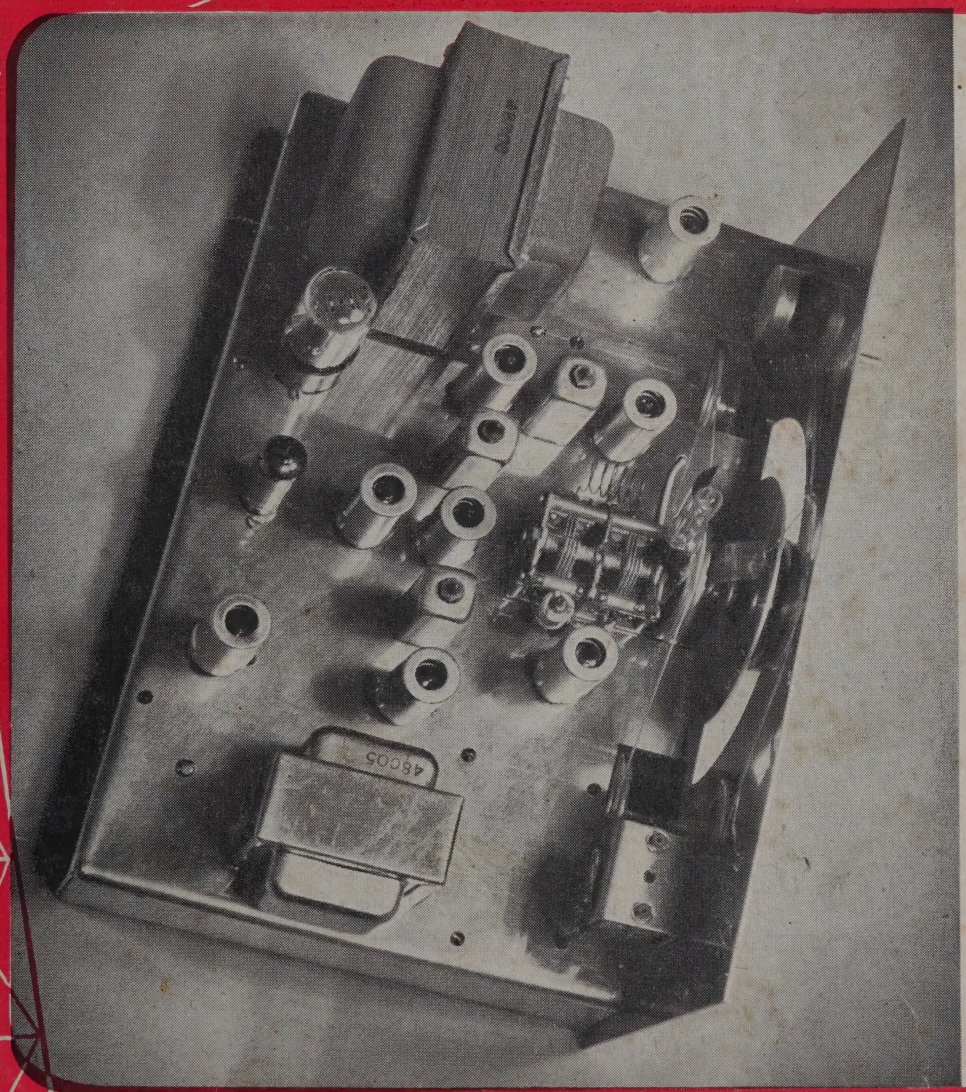


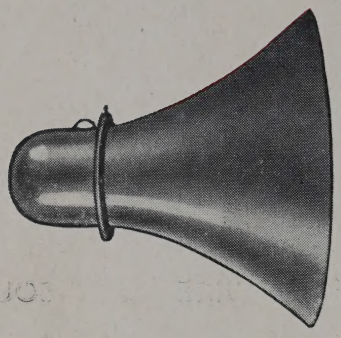
In this Issue

A 6-Metre Amateur Receiver

SEPTEMBER 1st, 1951 VOL. 6, NO. 7 1/10

STEANES SOUND SYSTEMS

HIGH EFFICIENCY LOW-PRICED FLARES For Sound Men



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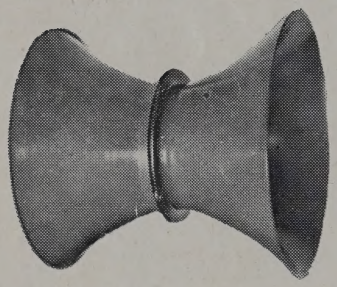

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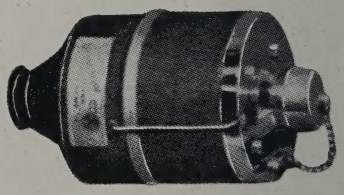

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RADIO AND ELECTRONICS

Vol. 6, No. 7 — 1st September 1951

Page

Editorial 2

The "Radel" 6-Metre Amateur Receiver 4

Tube Data:
The 832A Push-Pull R.F. Beam Power Amplifier 9

Shoes and Ships, by the Walrus 15

Why Not "T" Attenuators 18

The Philips Experimenter:
No. 47: A Compact and Sensitive Grid-dip Meter 24

Wellington Radio Traders' Association Notes 26

Personal Notes, Brigadier S. D. Mason 28

Prominent Australian Talks on Impact of Television 29

New Products: Latest Releases in Electrical and Electronic Equipment 30

The "Radio and Electronics" Abstract Service 35

For the Serviceman: H.M.V. Model 467D 37

Television Today and Tomorrow, by L. Marshall Gander 39

Letter to the Editor:
Training Servicemen for Television 42

Trade Winds 43

The N.Z. Electronics Institute (Inc.) Newsletter 45

Classified Advertisements 46

Publications Received 48

OUR COVER

This month's cover picture shows the external appearance of the 10-tube receiver designed and built in our laboratory for use on the 6-metre amateur band.

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CORRESPONDENCE

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The "Radel" 6-Metre Amateur Receiver

In the last issue of "Radio and Electronics" we forecast a series of articles covering both receiving and transmitting aspects of V.H.F. amateur work. The receiver described in this article is the first of the series, and sets a high standard of construction and performance which at the same time is well within the capabilities of the "ham" to build.

INTRODUCTION

On page 33 of our August issue, under the heading of "The R. and E. 1951 V.H.F. Programme," we devoted several paragraphs to an evaluation of the best type of receiver to build for working the bands from 50 to 420 mc/sec., and it is not proposed to go over all the ground covered a second time. Sufficient justification for the choice of the superheterodyne exists in the very fact that this type of receiver always makes its appearance when serious work on any frequency is contemplated, however high that frequency may be. Except for special purposes, "straight" receivers and super-regeneratives have always been superseded by the superhet when transmitting techniques have progressed beyond the modulated oscillator stage, and when selectivity has become desirable on account of increased band occupancy. The simple modulated oscillator transmitter has so many disadvantages that it is only natural for it to be replaced by M.O.P.A. or crystal-controlled transmitters as soon as valve development and circuit technique have caught up with the frequency. These days, crystal control on six metres, and even on 144 mc/sec. is by no means difficult to apply, and the overwhelming advantages of a transmitter which does not display large amounts of unintentional frequency modulation, which modulates without distortion to high percentages, and which can be relied upon to "stay put" at the required spot in the band, are such that they cannot be disregarded, even at the expense of a more complex transmitter. When a simple super-regenerative receiver is used to receive stable transmissions of this sort, there are no disadvantages except those inherent in the receiver itself, but as soon as activity increases, and the band becomes more fully occupied, the inherently low selectivity of simple receivers, not to mention their habit of radiating strong interference, and their relatively unstable performance characteristics, makes them less and less desirable, and more and more of a stop-gap, to be "ditched" at the earliest opportunity. In brief, it is a waste of a good transmitted signal, whatever the frequency, to use it in conjunction with an inferior receiver.

This, then, is the main reason for deciding on a superhet.

REQUIREMENTS FOR V.H.F.

Having settled upon the type of receiver, it is necessary to decide on a specification that will, in detail, satisfy the requirements of reception on the frequencies for which the set is to be used. The set is predominantly one for the six-metre band, but, as mentioned in the August article, we intend it to be suitable also as a "back end," to be used together with converters for the 144 and 420 mc/sec. bands.

This requirement conflicts to some extent with those of the six-metre band, but not very strongly, so that by effecting one or two suitable compromises, it should not be too difficult to design a set that will be not only useful, but a good performer, on all three bands.

(a) Selectivity and Image Response

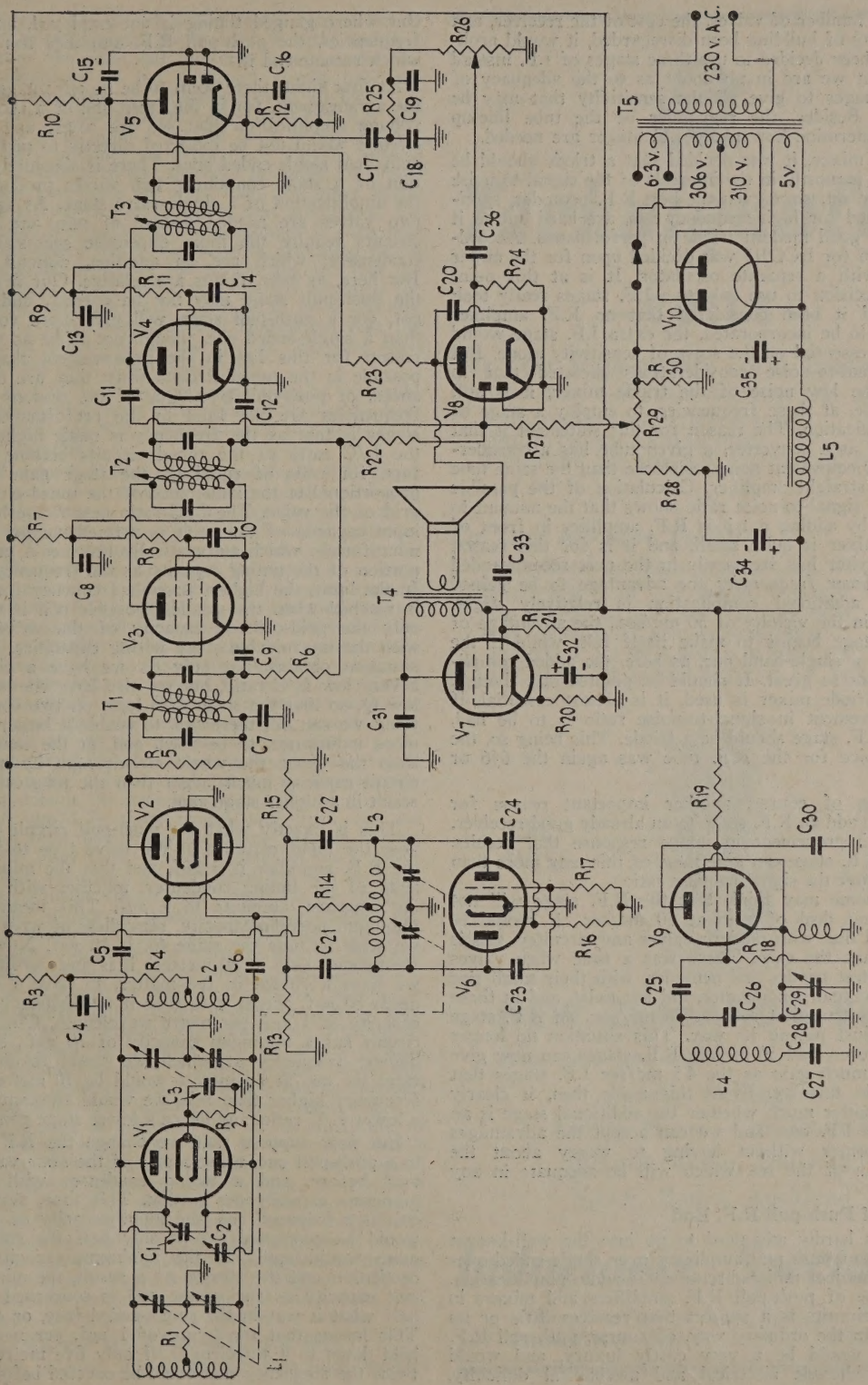
It is under this head that six-metre specifications must be relaxed in order to suit the other two bands. It is probable that by far the greatest activity on six is crystal-controlled, so that it would be possible to use a receiver for this band with as much selectivity as an ordinary communications receiver. If six metres only had to be considered, then the most satisfactory solution would simply be a converter, working into a communications receiver at, say, 4 mc/sec. or so. But this would give far too much selectivity for the 420 mc/sec. band, and too much for a good many signals on the two-metre band, where crystal control, though present, is not as widespread as on six. It is because of this that the basis of our reception scheme has been made a self-contained set for six metres. The I.F. has been chosen as 4.5 mc/sec.

This frequency is high enough to give good image rejection. With the oscillator on the low-frequency side of the signal, the image is 2 x 4.5, or 9 mc/sec. lower in frequency than the signal, so that even if no R.F. stage were used, we could expect the image response to be about 30 db. below the signal response. Also, with this much separation between signal and image, any image that may be received would come from outside the band. Indeed,. images could come only from the frequency range of 41 to 45 mc/sec. In this country at least, it is not very likely that many strong signals will occur within this range to cause image reception in any case, but since for other reasons it has been decided to install a tuned R.F. amplifier stage, the possibility of image interference is almost non-existent.

At the same time as ensuring good rejection of images, the I.F. of 4.5 mc/sec. is low enough to give about the right amount of selectivity. More could undoubtedly be used, as indicated above, but the selectivity obtained is not great enough to prevent the signals of reasonably stable modulated oscillators from being readable. With a converter, the set will be able to make the most of the six- and two-metre bands. At a later date, if six becomes too crowded for comfortable reception on this set, it would be a simple matter to add an extra converter and a stage of I.F. on, say, 455 kc/sec., or to pick off 4.5 mc/sec. from the existing I.F. channel, and use a conventional set as a sort of "V.H.F. Q5er," without wrecking the receiver as it stands.

(b) Sensitivity and Signal-to-Noise Ratio

I.F. stages on frequencies as high as 4.5 mc/sec. do not have nearly as much stage gain as their low frequency counterparts, so that at least two stages of I.F. are required, if the set is to be sensitive enough to reach down to the noise level. In practice, with the commercially available miniature 4.5 mc/sec. I.F. transformers, a stage gain of between 30 and 40 times can be realized when a 6BA6 is used as the I.F. amplifier. Two such stages, therefore, will give a gain of between 900 and 1600 times. This is considerably more than a single stage on 455 can do, and should be high enough for amateur purposes. Mobile commercial receivers, such as the taxi services use, use three and sometimes four I.F. stages—generally on a somewhat higher frequency than this—but amateur requirements are nowhere near as stringent as the ones these receivers have to meet.


230 v. A.C.
T5
6·3 v.
306 v.
310 v.
5 v.
V10
R30
C35
R29
L5
R28
C34
R26
C15
R10
V5
C16
R12
R25
C19
C17
C18
C36
R24
C20
T3
R11
C14
R9
C13
V4
C11
C12
R23
V8
R27
T2
R22
C33
R7
C10
R8
C8
V3
C9
R6
T4
R21
C32
T1
C31
V7
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R5
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C29
C4
C23
C28
R13
L4
C27
C3
R2
V1
C2
C1
R1
L1

Had the number of valves, the cost of the receiver, and the difficulty of building been disregarded, it would probably have been decided to use three stages of I.F. instead of two, but we are in no doubt as to the adequacy of the two stages to give all the sensitivity that may be necessary. Besides, the remainder of the tube line-up helps to determine how many I.F. stages are needed.

For the mixer, it was decided that a triode should be used. This is mostly in the interests of the signal-to-noise ratio of the set, since even the best R.F. pentodes, specially designed for high-frequency use, are hard put to it to equal a good modern triode in performance. Accordingly, a 6J6 (or ECC91) was decided upon for the mixer position, with a separate oscillator. It is at this point that the decision to use only two I.F. stages really took place. Had it been considered that no R.F. amplifier stage was to be incorporated, the extra I.F. stage would have been essential on the score of sensitivity alone. But again, signal-to-noise considerations dictated that in spite of the low noise of the triode mixer, it is still worth while, at these frequencies, to employ a stage of R.F. amplification. The reason for this statement is that when used as a converter, a given tube has a considerably higher equivalent noise resistance than the same tube used as a straight amplifier. Calculation of the possible increase in signal-to-noise ratio shows that the amount to be gained by adding a triode R.F. amplifier in front of a triode mixer is quite small, and it is for this reason that the writer has frequently in the past recommended that *for lower frequencies* the advantage to be gained from the additional complication is relatively slight. However, in the vicinity of 50 mc/sec., the advantage of an R.F. stage begins to make itself felt, while if the receiver is a single-band one, as here, the added complication is not so great. It should be pointed out, though, that if a triode mixer is used, it is almost essential, if any improvement in signal-to-noise ratio is to be had, that the R.F. stage should be a triode. This being so, the logical choice for the R.F. tube was again the 6J6 or ECC91.

There is, of course, another important reason for choosing to add an R.F. stage to an already good receiver. It is the improvement in image response that results. An extra I.F. stage can give none of this, any more than it can improve the signal-to-noise ratio.

Unless some may think that the R.F. stage will not give a great deal of gain at 50 mc/sec., it should be emphasized that with modern valves and circuitry, this is by no means the case. There was a time when valves like our latest triodes and pentodes, with their small size and high mutual conductance, did not exist, and in those days it was true that even at 20 mc/sec., an R.F. stage was only just paying its way. This situation no longer holds, however, and 50 mc/sec R.F. stages can now give almost as much gain as the 4.5 mc/sec I.F. stages that are used in this set. From this angle then, it clearly does not matter much whether the additional stage is an R.F. or an I.F. one, and we can accept the advantages of the former without having to worry about the overall gain of the set, which will be adequate in any case.

(c) Use of Push-pull R.F. End

There is hardly any need to go into the well-known advantages of push-pull amplifiers over single-ended ones when the subject under discussion is audio amplification, but the use of push-pull R.F. amplifiers and mixers in receiving circuits is a subject that receives little or no attention. In the ordinary way, of course, push-pull R.F. amplifiers would be a very costly luxury, and would bring considerable electrical and mechanical difficulty. But where ganged tuning is not employed, and at high frequencies, the push-pull R.F. amplifier has its points which recommend it.

At first sight, there seem to be no advantages at all in the arrangement, for in the front end of a receiver, it is voltage amplification that we are after, and push-pull circuits would not be expected directly to produce more gain than single-ended ones. There is absolutely no question of a stage containing two valves producing twice the amplification of a single-valve stage. As against this, two valves are needed instead of one, and the tuned circuits require the more expensive split-stator tuning condensers, which are, in addition, difficult to gang. But here, as ever, things are relative. Our first view of the push-pull stage may not be correct, and indeed is not, for a push-pull stage will give more voltage gain than a single-ended one, though not twice as much. The reason for this lies in the improvement that is made possible in the tuned circuits when they are of the balanced, or push-pull type. One of the reasons why high frequencies are not kind to the performance of R.F. stages is that as the frequency is made higher, so does the L/C ratio of the tuned circuits become lower. In fact, for coils of equal Q, the stage gain is directly proportional to the inductance of the tuned circuit in the grid of the valve. The L/C ratio gets worse because the input capacity of the valve is a fixed number of micro-microfarads, which automatically becomes a greater proportion of the tuning capacity as the frequency is raised. In the limit, the highest possible frequency for the valve is reached when the smallest possible coil is tuned with only the grid-cathode capacity of the valve, together with the unavoidable stray wiring capacities. When this situation obtains, not only do we have a circuit with a very low L/C ratio, but we also have one with a very low Q, so that the stage gain loses on two counts. Anything we can do, therefore, to enable a larger coil, with more inductance, to be used, and, at the same time, to keep the Q of the whole circuit high by making the circuit capacity much larger than the tube capacity, will result in a higher stage gain.

This is exactly what the push-pull circuit does. Suppose the input capacity of the valve type to be used as the R.F. amplifier is 3 $\mu\mu$f, and that the minimum capacity of the tuning condenser, together with stray wiring capacity, amounts to 7 $\mu\mu$f. This means that the minimum possible capacity, regardless of what frequency we wish to tune the stage to, is 10 $\mu\mu$f. Now at lower frequencies (say at 80 metres) it is quite ordinary, when we have a choice in the matter, to have a coil which needs 80 $\mu\mu$f. across it to tune it to frequency. This is a capacity of 1 $\mu\mu$f. per metre wavelength. Our imaginary circuit has a minimum capacity of 10 $\mu\mu$f., so that the highest frequency at which we could retain the L/C ratio we use at 80 metres would be 10 metres. At a frequency higher than this, we would automatically have a lower L/C ratio, and hence a lower stage gain.

But now suppose that we change the R.F. amplifier to a push-pull one, using a pair of the same valves as we used before, and a tuning condenser with the same minimum capacity per section. This time, since the circuit is a balanced one, the input capacity of each valve would be connected across only half the coil, and the same would apply to the minimum capacities of the condenser, and the strays. As a result, the minimum circuit capacity as far as the coil is concerned is exactly half what it was in the single-ended case, or only 5 $\mu\mu$f. This means that the figure of 1 $\mu\mu$f. per metre can be held down to a wavelength of only five metres—exactly twice the frequency that could be covered before with the

same stage gain. Of course, other things help to determine the stage gain besides the Q and L/C ratio, and they do not remain the same, but this does illustrate the tremendous advantage of the push-pull circuit over the single-ended one when the frequency is at all high.

In this receiver, the decision to use push-pull R.F. and mixer stages gives quite a notable improvement in performance, *at practically no extra cost.* This is because the 6J6 is a double triode, specially designed for push-pull circuits, that costs no more than any other valve, so that we get the two extra valves that are needed, for nothing. Also, the mechanical arrangement is such that even if single-ended stages were used no alteration would be necessary, and when we add to this the fact that the tuning condensers used, which are specially designed for V.H.F. work, are practically identical in price whether split-stator or single-ended, it will be realized that the advantages of push-pull in the present set have been obtained at very little, if any, extra cost.

As far as L/C ratio is concerned, there is no doubt that the push-pull circuits have enabled this to be kept high. The aerial and R.F. coils consist of five turns each, 9/16 in. in diameter!

Once it has been decided to use a push-pull R.F. stage, it becomes a matter of practical politics to use a push-pull mixer circuit, since it would be very inconvenient to have to change from push-pull to single-ended half way through the R.F. circuits. Thus, the grid circuit of the mixer is also push-pull. There are two ways of arranging a push-pull mixer circuit. One is to have a push-pull plate circuit, tuned, of course, to the intermediate frequency, and inject oscillator voltage in single-ended fashion to the two mixer grids. The other is to connect the plates in parallel, and to inject the oscillator voltage in push-pull to the grids as well as the signal. In this set the latter procedure was adopted. The main reason for the choice was that the commercial I.F. transformers it was desired to use did not include one with a push-pull primary circuit, so that the first arrangement would have meant using a home-made first I.F. transformer. This is not outside the bounds of possibility at this frequency, but would be more trouble and work, and we thought that most builders would agree with us on this point. At the same time, it is no trouble to use a push-pull oscillator, especially since a third 6J6 can be used. Indeed, the oscillator circuit used is perhaps the simplest possible, since it has no tickler winding to adjust, nor any critical features at all, and it automatically produces push-pull voltages for feeding to the balanced mixer grids. Another important advantage of having the oscillator in push-pull as well as the signal circuits, is that identical split-stator tuning condensers can be used for all three circuits, making the adjustment of the oscillator tuning range for tracking with the signal circuits very easy indeed. One very worthwhile point about this receiver is the great ease with which it can be adjusted to track perfectly. Not wishing to take credit where it is not due, it must be admitted that this is partly due to the small tuning range of the band to be covered, but it is also due in no small measure to the fact that identical tuning condensers make for easy ganging, just as in a broadcast set, especially when, as here, both the capacity and the inductance of each circuit can be individually adjusted. Builders need not be in the least scared of the fact that the receiver is ganged. The method of driving the three condensers works admirably, without backlash, and the electrical ganging is carried out more easily than that of many broadcast sets we have come across.

LINE-UP OF THE WHOLE SET

With this amount of preliminary discussion, readers

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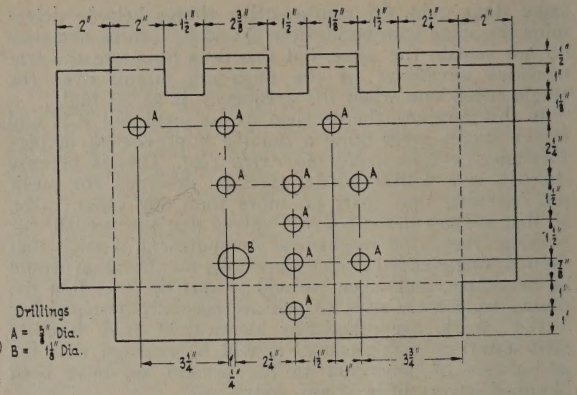
will be in a position to appreciate the line-up of the whole set, as follows:

R.F. Stage—1 6J6, cross-neutralized.
Mixer—1 6J6, grids in push-pull, plates in parallel. push-pull grid injection.
Local Oscillator—1 6J6, push-pull circuit, capacity coupled to mixer grids.
I.F. Amplifier—Two stages using 6BA6s, A.V.C. controlled.
Second Detector—Triode section of 6AT6, diodes unused.
A.V.C. Rectifier and First A.F. Amplifier—6AT6.
B.F.O.—6BA6.
Output—6AQ5.
Rectifier—5Y3-GT.

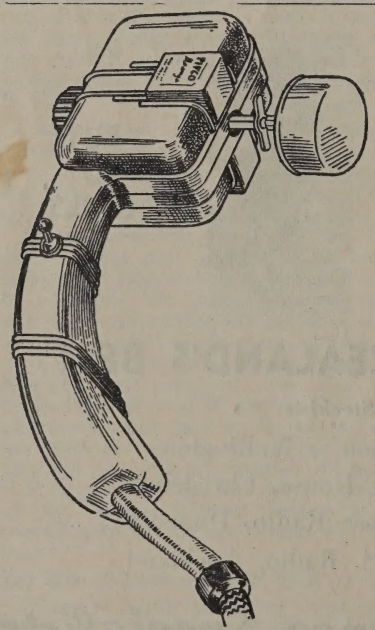
This gives ten tubes in all, and, as stated in an earlier article, we regard this as a general-purpose set, with no frills! It does demonstrate, though, that when one gets to the higher bands, performance has to be paid for in number of tubes used, if in no other way. Two I.F. stages, and a separate oscillator account for two extra tubes compared with a normal set, while the use of an infinite-impedance second detector takes another separate tube. This was used, incidentally, in order to get the utmost possible selectivity out of the three I.F. transformers. This kind of detector does not swamp the secondary of the last transformer, and so allows this winding to have the highest possible Q. Not a very large point, but every small one counts in the V.H.F. game. Of course, the B.F.O. could be dispensed with by those only interested in 'phone, and was included for the sake of completeness rather than with any idea of the amount of work it might get.



CIRCUIT IN DETAIL

Having discussed the reasons for the choice of stages at some length, there is not a great deal to be said about the detail of the circuits, which is conventional and straight-forward. The push-pull R.F. stage is no different from a typical transmitting circuit, except for the fact that it works as a Class A amplifier, with cathode bias. Since triodes are used, neutralization is necessary, or the stage would oscillate, so ordinary cross-neutralization was employed. With the very symmetrical layout of parts that is possible with the 6J6 tube, together with its split-stator condensers, neutralization presents no difficulties, although it must be done carefully. As long as

(Continued on Page 41.)



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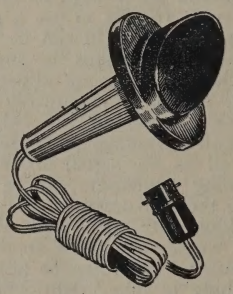

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TUBE DATA: The 832-A Push-Pull R.F. Beam Power Amplifier

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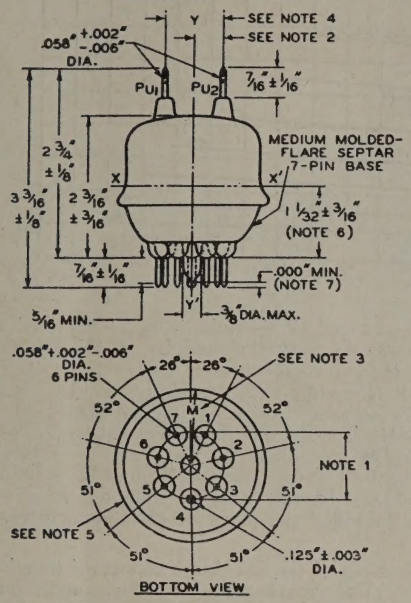
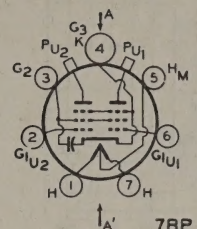


SOCKET CONNECTIONS
Bottom View



PLANE OF ELECTRODES OF EACH UNIT IS PARALLEL TO PLANE THROUGH AXIS OF TUBE AND AA'

PIN 1: HEATER
PIN 2: GRID NO. 1 of UNIT NO. 2
PIN 3: GRID NO. 2
PIN 4: GRID NO. 3, CATHODE
PIN 5: HEATER, MID-TAP
PIN 6: GRID NO. 1 of UNIT NO. 1
PIN 7: HEATER
P_{U1} & P_{U2}: PLATE TERMINALS OF UNITS NO. 1 and NO. 2, RESPECTIVELY

The 832-A is a heater-cathode type of transmitting tube containing in one envelope two beam power units. The tube is designed primarily for use as a push-pull R.F. power amplifier with maximum ratings at frequencies as high as 200 megacycles and with reduced ratings at frequencies as high as 250 megacycles. Its total plate dissipation is 15 watts for class C telegraph service. Neutralization of the tube is unnecessary in adequately shielded circuits.

The exceptional efficiency of the 832-A at the very-high frequencies is made possible by the balanced and compact structure of the beam power units, excellent internal shielding, and close electrode spacing. The internal leads are short and heavy in order to minimize internal lead inductance. The terminal arrangement provides excellent insulation and is designed to facilitate symmetry of circuit layout.

DATA

Unless otherwise specified, values are for both units

Heater, for unipotential cathodes:			
Heater arrangement	*Series*	*Parallel*	
Voltage (A.C. or D.C.)	12.6 ± 10%	6.3 ± 10%	volts
Current	0.8	1.6	Amp
Transconductance (approx.) for plate current of 30 milliamperes	3500		μmhos
Grid-Screen Mu-Factor	6.5		
Direct Inter-electrode capacitances (each unit)—			
Grid No. 1 to plate (with external shielding)	0.07 max.		μμf.
Input	8.0		μμf.
Output	3.8		μμf.
Grid No. 2 to cathode capacitance (approx. including internal grid No. 2 bypass capacitor)	65		μμf.
Bulb	T-16		
Base	Medium molded-flare Septar 7-pin		

Maximum CCS Ratings and Typical Operating Conditions

CCS = Continuous Commercial Service
Maximum Ratings are Absolute Values

As Grid-Modulated Push-Pull R.F. Power Amplifier Class C Telephony

Carrier conditions per tube for use with a max. modulation factor of 1.0.

D.C. plate voltage	750 max.	volts
D.C. screen voltage (grid No. 2)	250 max.	volts
D.C. grid voltage (grid No. 1)	—100 max.	volts
D.C. plate current	55 max.	ma.
Plate input	22 max.	watts
Screen input	3.4 max.	watts
Plate dissipation	15 max.	watts

Typical operation:

With modulation factor of	*0.8*	*0.9*	
D.C. plate voltage	500	750	volts
D.C. screen voltage	200	200	volts
D.C. grid voltage	—55	—60	volts
Peak R.F. grid-to-grid voltage	100	100	volts
Peak A.F. grid voltage	14	16	volts
D.C. plate current	44	29	ma.
D.C. screen current	3	2	ma.
D.C. grid current (approx.)	0	0	ma.
Driving power (approx.)‡	0.1	0.1	watt
Power output (approx.)	8	8.5	watts

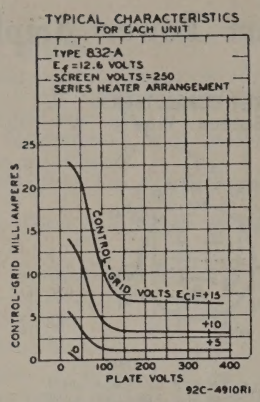
As Plate-modulated Push-Pull R.F. Power Amplifier Class C. Telephony

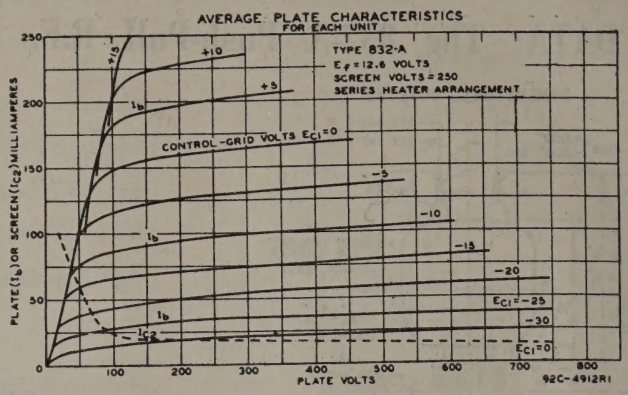
Carrier conditions per tube for use with a max. modulation factor of 1.0

D.C. plate voltage	600 max.	volts
D.C. screen voltage (grid No. 2)	250 max.	volts
D.C. grid voltage (grid No.)	—100 max.	volts
D.C. plate current	68 max.	ma.
D.C. grid current	6 max.	ma.
Plate input	22 max.	watts
Screen input	3.4 max.	watts
Plate dissipation	10 max.	watts

Typical operation:

D.C. plate voltage	425	600	volts
D.C. screen voltage:			





From a fixed supply of	200	200	volts
*From a series resistor of***	14000	25000	ohms
D.C. grid voltage:*			
From a fixed supply of	—60	—65	volts
From a grid resistor of	25000	25000	ohms
Peak R.F. grid-to-grid voltage	140	150	volts
D.C. plate current	52	36	ma.
D.C. screen current	16	16	ma.
D.C. grid current (approx.)	2.4	2.6	ma.
Driving power (approx.)	0.15	0.16	ma.
Power output (approx.)	16	17	watts

As Push-Pull R.F. Power Amplifier and Oscillator—Class C Telephony

Key-down conditions per tube without modulation†

D.C. plate voltage	750 max.		volts
D.C. screen voltage (grid No. 2)	250 max.		volts
D.C. grid voltage (grid No. 1)	—100 max.		volts
D.C. plate current	90 max.		ma.
D.C. grid current	6 max.		ma.
Plate input	36 max.		watts
Screen input	5 max.		watts
Plate dissipation	15 max.		watts
Typical operation:			
D.C. plate voltage	500	750	volts
D.C. screen voltage:			
From a fixed supply	200	200	volts
From a series resistor of	21000	37000	ohms
D.C. grid voltage:*			
From a fixed supply of	—65	—65	volts
From a grid resistor of	25000	23000	ohms
From a cathode resistor of	730	1000	ohms
Peak R.F. grid-to-grid voltage	150	150	volts
D.C. plate current	72	48	ma.
D.C. screen current	14	15	ma.
D.C. grid current (approx.)	2.6	2.8	ma.
Driving power (approx.)	0.18	0.19	watt
Power output (approx.)	26	26	watts

*The grid-circuit resistance should never exceed 25000 ohms (total) per tube, or 50000 ohms per unit. If additional bias is necessary, use a cathode resistor or a fixed supply.

‡At crest of audio-frequency cycle with modulation factor indicated.

**Connected to modulated plate voltage supply.

†Modulation essentially negative may be used if the positive peak of the audio frequency envelope does not exceed 115% of the carrier conditions.

INSTALLATION

The *base* pins of the 832-A fit the transmitting seven-contact socket designed for use with the septar 7-pin base. The socket should preferably be provided with floating contacts. If the tube is to be operated above 60 megacycles, the socket should be provided with built-in by-pass capacitors for heater and grid No. 2. The plate terminals take clips with flexible leads. Flexible leads are necessary so that strains will not be placed on the glass at the seals. Connections should never be soldered directly to the plate terminals as the heat of soldering may crack the lead seals. The 832-A may be mounted either up or down. It may also be mounted in a horizontal position provided the plane of each plate is vertical (on edge).

The *heaters* of the 832-A are connected together within the tube. The centre connection is brought out of the bulb to a separate pin terminal to permit either series operation from a 12.6-volt supply or parallel operation from a 6.3-volt supply. Under any condition of operation the heater voltage should not deviate more than ±10% from the rated value.

The *cathodes* of the 832-A are connected together within the tube. The cathode circuit should be connected to the electrical mid-point of the heater circuit when the heaters are operated from an A.C. supply or to the negative heater-supply lead when the heaters are operated from a D.C. source. In circuits where the cathode is not directly connected to the heater, the potential difference between them should not exceed 100 volts. If the use of a large resistor is necessary between the heater and cathode in some circuits, it should be bypassed by a suitable filter network to avoid the possibility of hum.

The *plates* of the 832-A show no colour when the tube is operated at its maximum plate-dissipation rating.

The *screens* of the 832-A are connected together within the tube and by-passed by means of a 65 $\mu\mu$f. condenser connected inside the tube between the screens and the cathodes. Screen voltage can be obtained from a separate source or from the plate-supply through a series resistor or by means of a voltage divider. The choice of method depends on the service in which the tube is used (see Application). When the screen voltage is obtained from a separate source, or from a voltage divider, plate voltage should be applied before or simultaneously with the screen voltage. Otherwise, with voltage on the screens only, the screen current may rise high enough to cause excessive screen dissipation. When screen voltage regulation is not an important factor, the series resistance method for obtaining screen voltage is desirable because of its simplicity and because it limits the D.C. input power to the screen. A D.C. milliammeter should be used in the screen circuit so that the screen current can be measured and the D.C. power

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input to the screen determined. The screens should not be allowed to attain a temperature corresponding to more than a barely perceptible red colour. This temperature corresponds to the screen input values as shown in the tabulated data.

The screen current is a very sensitive indication of the plate circuit loading and rises excessively (often to the point of damaging the tube) when the amplifier is operated without load. Therefore, care should be taken when tuning an 832-A under no-load conditions in order to prevent exceeding the screen input rating of the tube.

A protective device, such as a high-voltage fuse, should be used to protect both the plate and screen against overloads. When a voltage divider or a resistor in series with the plate voltage supply is used for obtaining the screen voltage, the protective device should be placed in the common positive high-voltage supply lead. It should remove the high voltage when the plate current reaches a value 50 per cent. greater than normal. When the screen voltage is obtained from a separate source or from a voltage divider of good regulation, a protective device should be placed in the screen-supply lead. It should remove the screen voltage when the screen current reaches a value of 50 per cent. greater than normal.

Shielding of the R.F. amplifier stage employing the 832-A is required for stable operation. A convenient method of shielding is to insert the plate end of the tube through a hole in a metal plate so that the edge of the opening is in close proximity to the internal shield of the tube. An alternative shielding and mounting arrangement is to insert the grid end of the tube through a hole in the shield and then clamp a ring or cup to the chassis so as to complete the shielding and lock the tube in the mounting.

R.F. by-passing of the 832-A at the tube terminals is necessary in order to realize the full capabilities of the tube at the very-high frequencies. Conventional by-passing methods and grounding are not adequate. One convenient method of by-passing is to use ribbon leads to the tube terminals and to insulate the leads from the external shield plate by means of mica spacers to form by-pass capacitors right at the tube terminals. It is important that the grid, plate, and screen circuit returns are made to the common cathode connection in order to avoid R.F. interaction through common return circuits. It may also be advisable in some applications to supplement the action of the by-pass capacitors by R.F. chokes placed close to the capacitors in the voltage-supply leads.

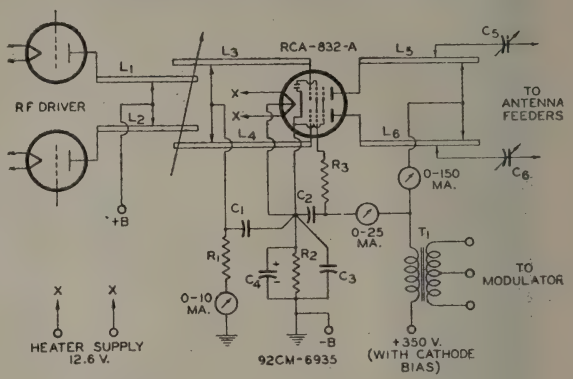
In order that the maximum ratings as shown in the tabulated data are not exceeded, changes in electrode voltage due to battery or line-voltage fluctuation, load variation, and manufacturing variation of the associated apparatus must be determined. An average value of voltage for each electrode should then be chosen so that under the usual voltage variations the maximum rated voltages will not be exceeded.

When a new circuit is tried or when adjustments are made, it is advisable to reduce the plate and screen voltages. This may be done conveniently by means of a protective resistance of about 10000 ohms (total) in series with the screen lead and a protective resistance of about 2000 ohms in series with the high-voltage supply lead.

APPLICATION

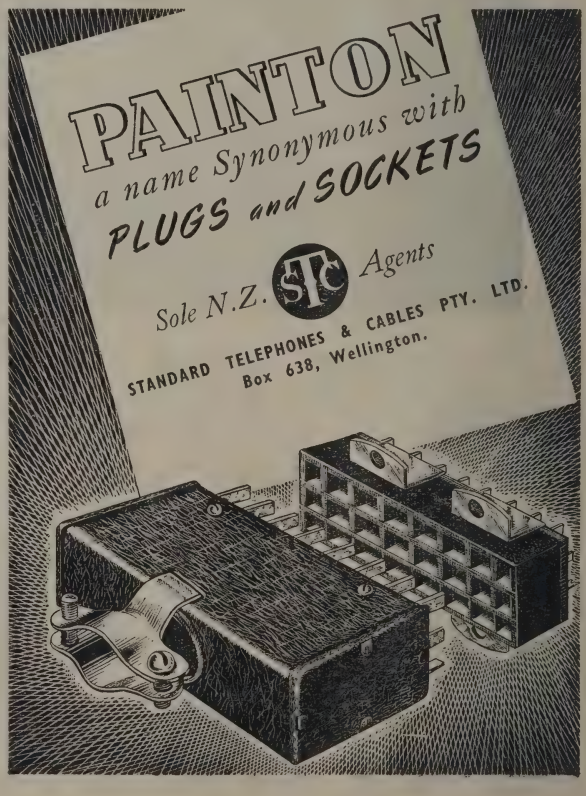
In grid-modulated class C telephony service, the 832-A is supplied with unmodulated R.F. grid excitation voltage and with D.C. grid bias which is modulated at audio frequencies. Grid bias should preferably be obtained from a fixed supply. The plates are supplied with

VHF PLATE-MODULATED
PUSH-PULL RF POWER AMPLIFIER
POWER OUTPUT 12 WATTS (APPROX.) AT 2 METERS



C_1, C_2, C_3 = 500 μμf
C_4 = 25 μf, 200 VOLTS
C_5, C_6 = 3 TO 35 μμf
R_1 = 10000 TO 20000 OHMS, 1 WATT
R_2 = 300 OHMS, 5 WATTS
R_3 = 7500 OHMS, 5 WATTS
L_1, L_2 = DIMENSIONS DEPENDENT ON TYPE OF DRIVER TUBE; APPROX. SAME AS L_5, L_6
L_3, L_4 = ¼" DIA. COPPER TUBING, APPROX. 10" LONG AND SPACED 1" BETWEEN CENTERS.
L_5, L_6 = ¼" DIA. COPPER TUBING, APPROX. 12" LONG AND SPACED 1" BETWEEN CENTERS.
T_1 = MODULATION TRANSFORMER

NOTE. ADJUST COUPLING OF L_1, L_2 AND L_3, L_4 FOR OPTIMUM GRID EXCITATION



unmodulated D.C. voltage. The audio power required in this service is very small. It must be sufficient to meet the peak power requirement of the grids of the class C amplifier on the positive crest of the input signal. The screen voltage should be obtained from a separate source or from a voltage divider connected across the high-voltage supply.

In plate-modulated class C amplifier service, the 832-A can be modulated 100 per cent. The screen voltage may be obtained from a separate source or from a voltage-dropping resistor connected in series with the modulated plate supply. The screen voltage must be modulated simultaneously with the plate voltage so that the ratio of screen voltage to plate voltage remains constant. Modulation of a fixed screen voltage supply can be accomplished either by connecting the screen lead to a separate winding in the modulation transformer or by connecting it through a blocking condenser to a tap on the modulation transformer choke. With the latter method, an A.F. choke of suitable impedance for low frequencies should be connected in series with the screen supply lead. Control grid bias may be obtained from a grid resistor or from a combination of either grid resistor and fixed supply or grid resistor and cathode resistor. The combination method has the advantage not only of protecting the tube from damage through loss of excitation but also of minimizing distortion through bias supply compensation.

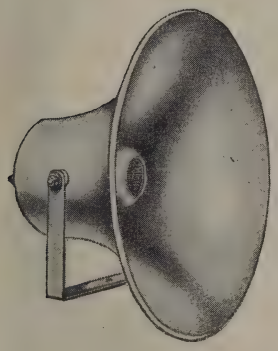
In class C R.F. telegraph service, the 832-A may be supplied with screen voltage from a fixed supply such as a voltage divider or from a separate source. The screen voltage may also be obtained from the plate voltage supply through a series resistor, provided the regulation of the plate supply is good enough so that the screen voltage will not exceed 600 volts under key-up conditions. Grid bias may be obtained by any convenient method.

The 832-A may be operated at maximum ratings in classes of service at frequencies as high as 200 megacycles. The tube may be operated at higher frequencies provided the maximum values of plate voltage and power input are reduced as the frequency is raised (other maximum ratings are the same as shown under Maximum Ratings and Typical Operating Conditions). The tabulation below shows the highest percentage of maximum plate voltage and power input that can be used at frequencies up to 250 mc/sec.

Frequency.	200	250	Mc.
Max. permissible percentage of max. rated plate voltage and plate input:			
Grid-mod. class C R.F. amplifier	100	94	per cent.
Plate-mod. class C R.F. amplifier	100	89	per cent.
Class C telegraphy	100	89	per cent.

TRUVOX

SENIOR and JUNIOR REFLEX HORN SPEAKERS



Model SD26.
"Senior" Reflex
P.A. Speaker, **without** transformer
V.C. 7.5 ohms
Response 275-8,000 c.p.s.
Capacity 10 watts.

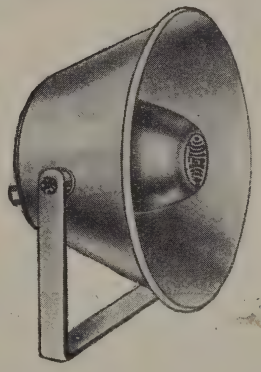
Dimensions and Weights

Model SD26 (without transformer)

Flare diameter	15⅝ ins.
Back to front depth	10 ins.
Weight	8 lbs. 10 ozs.

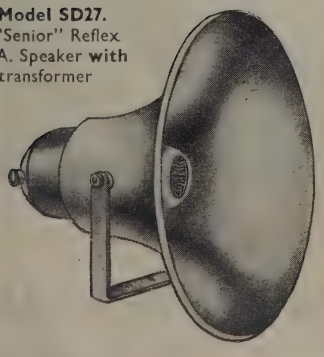
Model SD27 (with transformer)

Flare diameter	15⅝ ins.
Back to front depth	12¼ ins.
Weight	11 lbs. 4ozs.



Model SD24
"Junior" Reflex
P.A. Speaker, **without** transformer
V.C. 7.5 ohms
Response 400-7,000 c.p.s.
Capacity 5 watts

Model SD25
"Junior" Reflex
P.A. Speaker, **with** transformer.



Model SD27.
"Senior" Reflex
P.A. Speaker **with** transformer

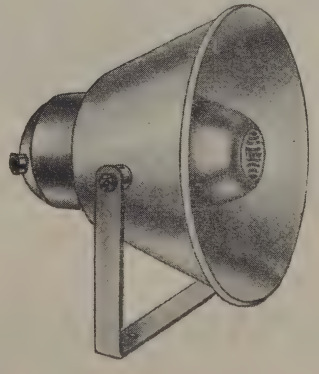
Dimensions and Weights

Model SD24 (without transformer)

Flare diameter	10⅝ ins.
Height from bottom of bracket to top of flare	11¼ ins.
Back to front depth	6¼ ins.
Weight	8 lbs. 1oz.

Model SD25 (with transformer)

Flare diameter	10⅝ ins.
Height from bottom of bracket to top of flare	11¼ ins.
Back to front depth	9¼ ins.
Weight	10 lbs. 6ozs.



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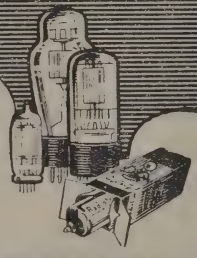

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SHOES and SHIPS

"The time has come," the Walrus said,
"To talk of many things. . . . "

By Special Arrangement with the Walrus

THOUGHTS ON ODD ITEMS

From time to time one comes across different things in radio sets which provide more than just a little food for thought. In this enlightened age, manufacturers provide very full application data for their various products solely for the purpose, it appears, of being ignored by other manufacturers who incorporate such components in their equipment. This particular crusade is levelled against those unfortunates who believe a half-watt resistor is adequate for any position in a modern receiver, and so it is, if you aim to convert it to a radiator! To begin with, one of the most frequently under-rated resistors is the oscillator feed resistor supplying B + to the plate of the triode section of tubes like the 6K8. The manufacturers' data on this type of valve shows that with a H.T. voltage of 250 on the hexode plate the triode plate should be operated at 100 volts. This means dropping 150 volts and, as the plate current is given as 4 ma., near enough, the wattage dissipation comes out about 0.6 of a watt. This, of course, makes a $\frac{1}{3}$-watt resistor look very distressed and a $\frac{1}{2}$-watt one somewhat fatigued. The answer, of course, is to install a resistor of adequate rating, preferably, in this case, positioned away from the oscillator coil where the temperature rise will not cause frequency drift. The same limitations are imposed by screen and plate dropping resistors for other valves, particularly the second detector audio amplifier tube. The total current flowing may not be great, but the voltage dropped across the resistor is considerable and can easily exceed the maximum rated dissipation. In the case of the normal carbon impregnated resistors, operation for a long time at excessive temperatures causes the value to change and they nearly always increase in resistance. This is a frequent occurrence with carbon resistors employed in the centre tap of the transformer H.T. secondary to derive negative bias. Very suspicious, very doubtful, always check!

Ordinary condensers can also prove troublesome if operating without sufficient safety margin, but this is not so common mainly because their conditions of use are more readily appreciated. The inter-valve coupling condenser is the most important member, for if it is at all inclined to be leaky, distorted reproduction will ensue not to mention possible damage to the valve which it feeds.

* * *

Turning now to another point, one finds all sorts of queer ideas are prevalent concerning the fitting of a pick-up to a radio set. Some of the hook-ups one stumbles upon every so often are shockers and make one wonder just how much our paying friends, the public, will put up with. Of course, it is just possible that little Willie, who once fixed a fuse in the house, did the job—it would be better to think so anyway! Basically, the idea should be to provide a switch to select either radio or gramophone, the radio volume control to work the pick-up level also, and for the radio to be effectively muted when playing records. An added refinement would, of course, be to include some bass correction on pick-up, but in the average radio set this is not generally possible through lack of sufficient gain. Also it is desirable where possible to ensure that radio and pick-up levels correspond within reason for the same setting of the volume control. This little consideration can save some

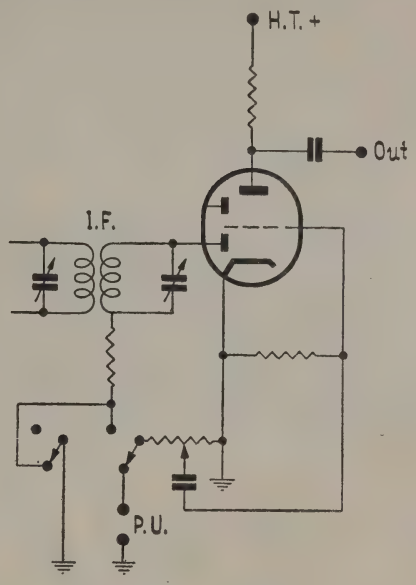

Fig. 1

awful shocks to the nervous system on occasion when switching from one to the other, not to mention avoiding a cheerless half hour getting the very young back to sleep again! Two reliable methods of wiring in a pick-up and selector switch are shown, that in Fig. 1 is a case where the volume control is used as the diode load and the valve is biased by normal grid leak and condenser bias—a very common arrangement. A double-pole double-throw switch is used as the radio-gram selector and radio mute by earthing the secondary of the I.F. transformer. Fig. 2 shows another system, where the volume control is the grid circuit fo the first audio valve which is cathode biased. The muting is not shown in this circuit but can be done as in Fig. 1. Note, however, that earthing the volume control side of condenser C_1 may not prove satisfactory since some break-through can still occur. Other alternatives are to open circuit the screen supply to the R.F. valves when switched to "records" or increase the bias on the first I.F. valve by switching in a considerably larger value of bias resistor than normal.

Where the reproduction from the pick-up seems to have too much top a small capacity connected across the pick-up terminals may reduce a lot of record scratch and make the results easier to listen to. Bass lift, of course, is very desirable, but generally means adding more audio amplification, which is rather more trouble to provide than the average person is prepared to pay for.

The crystal pick-up is a notable exception to the general run of pick-ups in that it has a rising bass response with a high output voltage. To correct fully for the recording characteristic, some bass lift should be provided even with a crystal pick-up but then plenty of out-

put is available from the pick-up to do this on an ordinary radio.

* * *

Set constructors and servicemen may have experienced trouble at different times with R.F. instability in receivers. Factory-built sets should, of course, not be troublesome in this respect, but in home-built receivers it is a common fault, particularly where unshielded coils are used. Careful placement of the aerial coil and R.F. coil is essential and in this respect a very wise move is to mount them in opposite planes to each other. That is, one horizontal to the chasis and the other vertical. The local oscillator coil, of course, is not critical in this respect. Too high a voltage on the screen grids of the

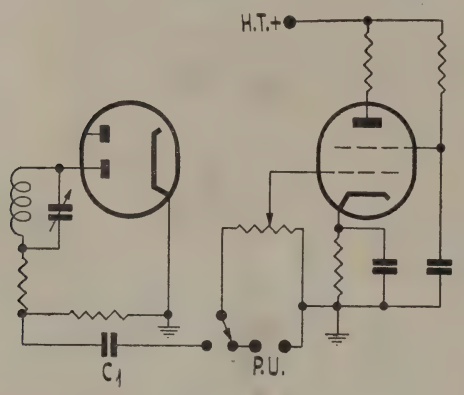

Fig. 2

valves may cause instability, also insufficient by-passing. In persistent cases where the set just will not "sit down" removing the by-pass condenser on the cathode of the R.F. valve will almost certainly do the trick. This dodge introduces a certain amount of negative current feedback over that stage, thereby reducing the gain slightly. Often a receiver that is unstable without an aerial connected is perfectly satisfactory when connected to a decent aerial. A piece of metallic shielding braid slipped over the short lead to the aerial coil from the aerial terminal makes a more satisfactory job and doesn't presuppose the use of an aerial anyway, which is a dangerous supposition to make these days!

Progressing now from one end of the set to the other, some thoughts have occurred to the writer on infinite speaker baffles. Many people have formed the impression that the dimensions for these vented enclosures are supremely critical to the last sixteenth of an inch. Such, however, is not the case for the idea basically is to load the cone heavily at the resonant frequency of the speaker and iron out the peak. This, theoretically, occurs at one certain volume of cabinet enclosure for a particular speaker having regard to its cone diameter and resonant frequency. The loading curve, however, is a broad one and measurements do not have to be so scrupulously exact; rather more important is rigidity in the enclosure itself and lack of cabinet resonance.

One well-known audio engineer in Britain who has produced a book on sound reproduction, went to a lot of trouble over vented baffles and rather exploded a lot of popular ideas on the subject. He did find, however, that lack of resonance and strength in the box was very necessary and to this end a brick box was the best arrangement. Either brick or marble that is, so readers

(Continued on Page 48.)

Mullard

VALVE NEWS

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1 Min., 1 M/a.
A.C. Resistance Max., 300 ohms.

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Voltage Reference Tube

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1 Min., 1 M/a.
A.C. Resistance Max., 450 ohms.

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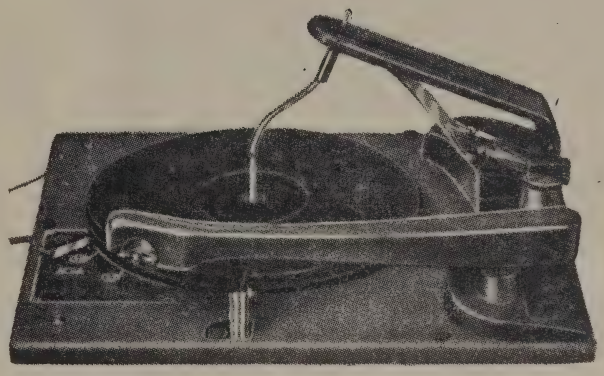

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Why Not "T" Attenuators?

A most neglected, but exceedingly useful piece of apparatus is the "T" attenuator, which is not difficult to build or use, and can replace much more expensive pieces of apparatus for many purposes.

INTRODUCTION

Many amateur and servicemen's workshops posses relatively advanced equipment, such as oscilloscopes and audio oscillators, which makes it all the more remarkable that these same workshops and their owners are very often quite lacking in one of the most useful bits of gear it is possible to have around, namely, the calibrated attenuator. Sometimes it is because commercial calibrated attenuators are quite expensive, but more often, we think, it is because the usefulness of such things is not nearly as widely appreciated as it should be. The attenuator, to be sure, is by no means as spectacular a device as a 'scope, or an oscillator, or a V.T. voltmeter, and this may also have something to do with it, but it is nonetheless every bit as useful in the radio workshop or laboratory as any of these. Indeed, there are many things for which a calibrated attenuator can be used, thereby removing the need for, say a 'scope or a V.T.V.M., so that these expensive items can either be dispensed with, or released for other work. Moreover, with the aid of a good multimeter, a perfectly good calibrated attenuator can be made for no more than the cost of a handful of carbon resistors and a wafer switch.

WHAT IS AN ATTENUATOR?

Many people have the idea that an attenuator is simply a "volume control" with a highbrow name! In one respect, it does the same job as the volume control, in that it provides a controllably smaller output voltage than the input applied to it, but here the similarity ceases. An attenuator is a device which reduces the power or voltage of a signal by accurately known amounts. That is to say, unless it is calibrated, it really has no title to the name at all. The volume control, or potentiometer, as it is always, but erroneously called, can have some pretensions to becoming an attenuator if it is provided with a dial and a calibration, but it has one major disadvantage that prevents it from being used in this way where any sort of accuracy must be preserved. By now it should be clear that an attenuator is a measuring device, as indeed it is, and, as the term is ordinarily understood, it is capable of as much accuracy as we like to build into it. In order that it may have this desirable characteristic, it is essential that when it is used in a circuit, it shall not in any way disturb the normal operation of that circuit. This last will be recognized as one of the properties of the ideal voltmeter, but the ideal voltmeter, which would draw no current from the source of voltage being measured, is a basic impossibility. It is possible to approach the ideal, in some cases very closely indeed, but never to quite reach it. The attenuator, on the other hand, is able, in theory, to realize the ideal of a measuring instrument that does not disturb existing circuit arrangements, and in practice, it can be made to come much closer to ideal performance than do most voltmeters.

Thus, since the attenuator is a very old device, that has been standardized in form for a long time, its name has come to represent certain standard arrangements of resistors, with the two useful properties of producing exactly known amounts of attenuation, and at the same time, of having no noticeable effect on the circuit with which they are used, when properly applied.

FORM OF THE ATTENUATOR, AND ITS SPECIAL FEATURES

In Fig. 1 (a) is shown the common "potentiometer," so widely used in radio sets and amplifiers for adjusting the input voltage so as to give the desired output. As mentioned above, it would be possible to give it a dial, calibrated in percentage of the input voltage, in arbitrary units, or with a decibel scale. As such, it would not be a very accurate device, because it is not possible to set a continuously variable control such as this at all accurately. A simple means of getting known steps of output would be to do something like Fig. 1 (a). Here the circuit is the same, but fixed resistors and a switch ensure that definite and repeatable steps can be made.

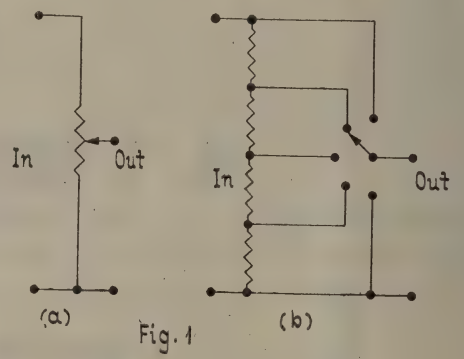

Fig. 1

Both arrangements suffer, however, from the same fault, namely, that the impedance to ground from the output point depends on the setting of the control. This is very noticeable in audio amplifiers in which a triode valve follows the volume control. For ordinary purposes, the effect is hardly noticeable, but where measurements have to be taken, such as when the amplifier is used as part of an oscilloscope, and the frequency response is important, it is very serious indeed. The input capacity of the triode shunts the output tapping, and is constant in value at all settings of the control, but its effect is different for every setting. At very low settings, we have a small capacity connected across a very low resistance, so that there is only a negligible effect on the frequency response. But when the control is near the middle of its travel, the same small capacity is across a much higher resistance, and in many cases, the capacity is large enough to cause an appreciable falling-off in the high-frequency response. As higher settings are reached, the effect becomes smaller again, because the smaller resistance of the upper portion effectively parallels the high-resistance lower portion, thus causing a reduction in the impedance between the moving arm and ground. In measuring applications, this is very undesirable, and can be reduced, but not eliminated, by reducing the resistance of the potentiometer. Where the pot. comes between two valves, it is not possible to reduce its value much, because doing so reduces the gain and increases the distortion in the first stage. Similarly, when the control follows a diode detec-

tor, reducing its value vastly increases the distortion produced by the detector.

In addition, if the stepped version is to be relied upon always to give the same fraction of the input at every setting, it can only do so, theoretically, when the device which the tapping point feeds has an infinite impedance to ground. In practice, things are not so bad, but the impedance connected to the output needs to be at least 10 times the total resistance of the potentiometer chain if the division ratios are to be as marked on the tapping points.

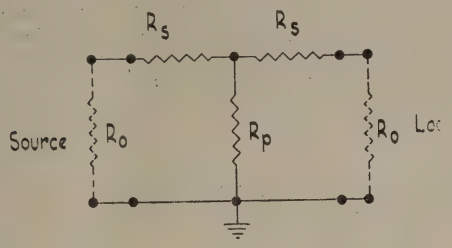

Fig. 2

This is where the proper attenuator comes in. One of the commonest types, mentioned at the head of this article, is the "T" attenuator, so called on account of the fact that it is made up of three resistors arranged in the form of a capital "T". Such an attenuator is shown in Fig. 2. Attenuators like this can be made to have any impedance that may be desired, by making them of larger or smaller resistors, so that they can be constructed so as to be suitable for connection in high or low-impedance circuits at will. It will be noticed that the two series arms are always equal (in this case R_s) but different in value from the parallel arm, R_p. The ratio between R_s and R_p determines the amount of attenuation that occurs, while the absolute sizes of the resistors determine the impedances occurring at both the input and the output terminals. For instance, if R_s is four times R_p, the attenuation will be approximately ten times, or 20 db; however, the larger the resistors, the higher will be both the input impedance and the output impedance of the attenuator. Also, since the arrangement of the three resistors is symmetrical, the input and output impedances must be equal, irrespective of what the impedance is, or the amount of attenuation. *This is why the T attenuator can be inserted in a circuit without affecting it in any other way than introducing attenuation.*

WHY IS IT SO USEFUL?

At first sight, an attenuator may not seem to have very many uses, but such a conclusion is quite wrong. Its main uses are (a) to do the same job as the ordinary volume control, only rather better, (b) to produce known output voltages from a larger known input voltage, and (c) to measure gains and losses in amplifier circuits.

In capacity (a), its usefulness is that it works without any noticeable alteration in the characteristics of the rest of the apparatus, rather than that of giving known amounts of attenuation, although the latter property is usually made use of at the same time. For instance, in high-class equipment such as the audio amplifiers, preamplifiers, etc., in a broadcast or recording studio, it is standard practice to terminate all separate pieces of gear in a step-down transformer at the output, or a step-up transformer at the input. The transformers are arranged to bring all inputs and outputs to the one low impedance level, such as 200 or 500 ohms. Then, in order to see that no amplifier is overloaded, and at the same time to give control of the output in the ordinary way, attenuators are placed in the 200- or 500-ohm lines that interconnect the amplifiers. The main purpose of doing this is two-fold. It enables the actual amplifiers to be housed in a rack, remote from the control desk, while the controls are on the desk, as far as we please from the equipment itself. This is essential in itself because it would be quite impossible to control everything by means of "volume controls" of the usual kind, built into the amplifiers, because of the physical impossibility of arranging so much gear in such a way that the control shafts can be brought out to the control panel in suitable positions. The other main purpose is that a low-impedance attenuator, between transformers, is the only way to control volume level without affecting the frequency response of the equipment.

The above has been included in this article simply as an interesting illustration, since few of our readers are likely to be building equipment along these lines. It it is (b) and (c) above that we will find our own real uses for attenuators. Most of us are familiar with standard signal generators, even if we do not own one. Any signal generator really worthy of the name includes an accurate attenuator, for the following reasons: First of all, it is required that the signal generator shall be able to deliver known output in terms of microvolts. Now it is a relatively easy matter to generate and measure R.F., or A.F., at a level of one volt or more, but almost impossible to do so at a level of a few microvolts, or even millivolts. Thus, if we are to have R.F. voltages, accurately known, down to one microvolt or less, or A.F. voltages down to one millivolt or so, there is only one practical way to do it. This is to generate a much larger voltage, such as one or ten volts, and to measure this with a meter, which can readily be arranged to do so. Then, an accurate attenuator is fed at its input with the known high voltage. By careful design and construction of the attenuator, accurate smaller voltages down to one-millionth of the input voltage can be supplied at its output terminals. This use of the attenuator has become so comonplace in R.F. signal generators that it hardly excites comment from anyone, but such an attenuator, either as a separate entity, or built into an A.F. signal generator can be just as useful in the audio field, and this is a fact which seems to have been completely overlooked by users and makers of A.F. test gear alike.

It is hoped to say more about the use of attenuators later in this article.

THE IMPEDANCE QUESTION

Readers will notice that we have already started to talk about input and output impedances. Now this is a subject that a good many people are not very clear on, so we will try and explain a little about it.

If an attenuator is to be inserted at a certain point in a circuit, it must satisfy two conditions. First, it must give the required amount of attenuation; secondly, it must not upset the voltage that *was* at the point where it is inserted, before the insertion took place. Otherwise, there will be a known amount of attenuation, caused by the attenuator itself, but *in addition,* a change in the output voltage at the point feeding it. This may be an increase or a decrease, according to circumstances, but in any case, it will cause the effect of inserting the attenuator to be different from the calculated value due to the attenuator itself. For this reason, it is most important to be able to adjust the input impedance of the attenuator to the same value as was connected across the voltage source before. For example, suppose the source is

the plate of a resistance-coupled valve. Before adding the attenuator to the circuit, the valve had a plate load resistor of 25k., and this was connected through the usual blocking condenser to a grid leak of 100k. We want to put in an attenuator between the blocking condenser and the grid resistor, and we want the previous valve to still have the same impedance of 100k. connected to the output end of the condenser. Thus, the input and output impedances of the attenuator are both required to be 100k. On the input side, if this is the case, the first valve will work into an impedance of 100k., as it did before, and on the output side, the grid of the second valve will also look into an impedance of 100k., so that for neither valve will the operating conditions have been changed, while the desired degree of attenuation will have been inserted.

$$R_s = R_o \left(\frac{A+1}{A-1} \right)$$

$$R_p = R_o \left(\frac{2A}{A^2-1} \right)$$

In these formulae, R_s R_p, and R_o have the same meanings as before, and the new quantity, A, is the ratio of the input and output voltages. For instance, if the output is to be one-half the input voltage, then $A = 2$, and we have:—

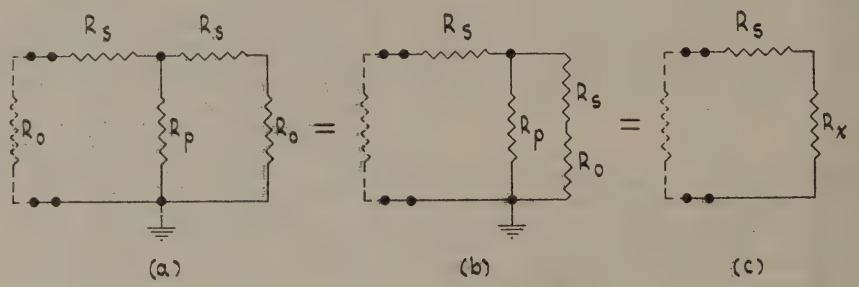

Fig. 3

Another practical example, is when an extension speaker is to be fed from a transformer, and it is desired to effect a permanent reduction in the power fed to the speaker, without having to alter the amplifier gain control, which would affect other speakers at the same time. Suppose it is a 15-ohm speaker, fed from, of course, a 15-ohm winding on the transformer. We break the speaker leads, and place the attenuator in the gap. On the one side, we now have the transformer secondary, and the output valves of the amplifier, and if these parts are to work just as before, the attenuator input terminals must look to the transformer secondary like an impedance of 15 ohms. On the other side, we have the speaker, which, if it is to work as before, must connect to somethink that looks like an impedance of 15 ohms. Clearly, a T attenuator satisfies both these conditions, and at the same time supplies less power to the speaker, as was required in the first place.

It is for this reason that in Fig. 2 we have shown, dotted, a resistor R_o, terminating both input and output of the attenuator. At the input, R_o represents the internal impedance of the source of voltage, and at the output it represents the impedance of the load.

HOW ATTENUATORS ARE WORKED OUT

First of all, it must be realized that particularly in the case of the load, R_o is really a part of the attenuator, just as much as are R_s and R_p. This is because if the attenuator is designed for a particular impedance, as it must be, but a different impedance is connected to the load, *then the amount of attenuation will not be what has been calculated,* but something quite different. Luckily, it is a very simple matter to work out the values of R_s and R_p for any required attenuation and any impedance. In the case of the T attenuator, to which we are confining ourselves, the two formulae are as follows:—

$$R_s = R_o \cdot \left(\frac{2-1}{2+1} \right) = \frac{1}{3} R_o.$$

$$\text{and } R_p = R_o \cdot \frac{4}{3}$$

Thus, if the attenuator is to have an impedance of 15 ohms, for insertion in a 15-ohm speaker voice-coil lead, $R_p = 15$, and $R_s = 5$ ohms, and $R_p = 20$ ohms. From this it can be seen that for a given amount of attenuation, both R_s and R_p are proportional to R_o, so that if values are worked out for one impedance, the values for other impedances are to be got by simple proportion. For example, for an attenuator to give half the output voltage, but with an impedance of 150 ohms, R_s would be 50 ohms, and R_p, 200 ohms. It can be seen, therefore, that the business of calculating the correct values for any impedance and any attenuation factor is very simple indeed, and need not scare off anyone. If attenuators are to be calculated for a particular number of decibels, then the *voltage* attenuation factor for that number of db. must first be worked out, and the factor used in the above formulae. For example, an attenuation of 6 db. is obtained by reducing the voltage to one half of what it was, so that the attenuation factor A is 1½, or 2. Similarly, for 3 db. attenuation, the voltage is reduced to 0.707 of the previous value, and the attenuation factor is 1/0.707 = 1.41. Likewise, an attenuation factor of 10 reduces the output by 20 db., and so on.

VARIATIONS OR STEPS

So far, we have only discussed a simple single-section attenuator which can do no more than give one fixed step of attenuation. This will probably not appeal as being very useful, so that the question arises of what can be

done to give readily adjustable attenuation, either in discreet steps, or by continuous variation, as with the simple volume control. For the latter, and where constant input and output impedances are of first importance, rather than accurately known steps, continuously variable attenuators, or T-pads, as they are often called, are made by ganging together on the same shaft three variable resistors. These cannot be ordinary potentiometers, because their law of variation of resistance with rotation must at all times obey the formulae. These pads are not expensive, but are not available in this country.

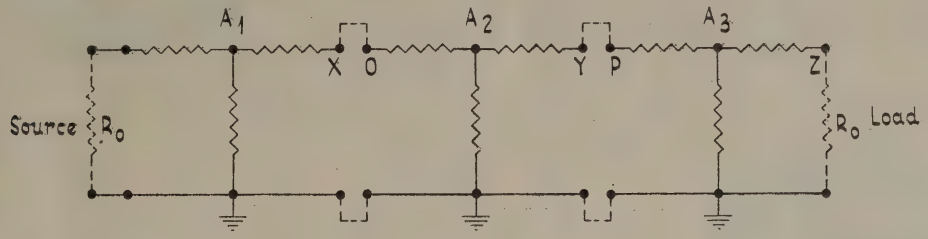

Fig. 4

However, owing to the peculiar property of the T attenuator of having equal input and output impedances, it is possible to get differing amounts of attenuation simply by caseading a number of them, as in Fig. 4. Since each has the same input and output impedance, we can connect two of them together without in any way affecting either's attentuation, and without affecting the input impedance of the first, or the output impedance of the second. Now this property is really quite remarkable, but it is very easy to see how it comes about. In Fig. 3 this is illustrated. At (a) we have what is essentially the same as Fig. 2 At (b), we have the same elements, the only difference being that they are re-drawn in a different way. Here we have R_s, in series with a parallel combination. The latter consists of R_p, paralleled by the other R_s, in series with R_o, the load. If we work out the resistance of this parallel combination, we will find that the value is such that together with the first R_s, it adds up exactly to R_o. This is emphasized in Fig. 3 (c), where the parallel combination of R_p, R_s, and R_o is represented by R_x. If you have any doubts about this, it is an interesting exercise to work it out in steps for the 6 db. 15-ohm attenuator used above as an example. It works!

Now since the resistance looking into the input terminal (which is what we have just worked out) is equal to R_o, it cannot possibly affect the first attenuator A_1, if the

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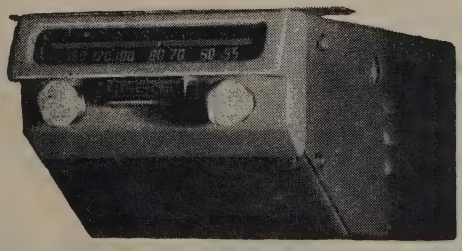

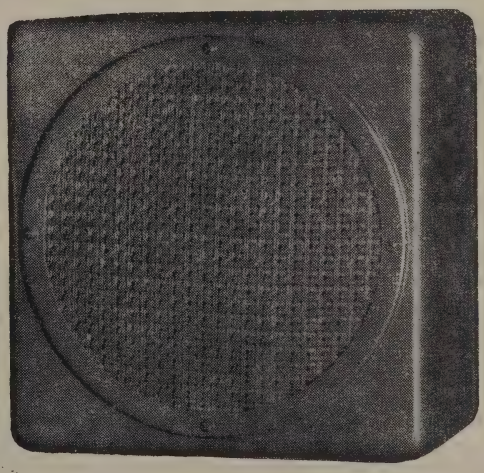

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input terminal of A_2 is connected to its output, and so on, so that as long as the last section is terminated by a load equal to R_o, one can string T sections together indefinitely and the only effect on anything is to increase the attenuation.

Fig. 4 shows one practical, but rather cumbersome method of using several attenuator sections to get different amounts of attenuation. For example, if the input and output terminals of each section are brought out to banana sockets, plugs and inter-connecting links can be used to select any single section, or any combination of them in cascade. If we had a number of sections, as follows, it would be possible to get any attenuation up to a maximum of 60 db. in steps of 1 db.

20, 20, 10, 4, 2, 2, 1, 1.

Now if the impedance of the sections was suitable for connecting to an audio oscillator with an output of 10 volts, it would be possible to have outputs in steps of 1 db. from 10 volts to 0.01v., or 10 millivolts. This is obtainable at the cost of 24 resistors, and some plugs and sockets and would convert the oscillator into a very useful measuring device, as well as a signal source. For instance, supposing it is required to know the output voltage of a gramophone pick-up, given an amplifier and an output meter, and, of course, a record. The output meter can be used purely as an indicator, and not even as a meter, in the following way. The record is played, and the amplifier's volume control is set to give a certain meter deflection at, say the loudest part of the record, and preferably where the output is fairly steady in value. Then, without changing the volume control setting, the pick-up is disconnected from the amplifier, and the calibrated attenuator is connected in its place. The output of the A.F. oscillator is connected to the input of the attenuator. The latter is adjusted until the output from the amplifier is as close as possible to the meter deflection noted before, for the record, and then give the output voltage of the pick-up as so many db. below 10 volts. Preferably, of course, the test should be done with a frequency record giving a steady tone at fixed frequency, and with the oscillator adjusted to the same frequency, or near it.

Another method of connecting attenuator sections that is somewhat more convenient in use is shown in Fig. 5. Here, double-pole leaf switches are used at the input and output of each section, with bridging connections which are brought into circuit when the corresponding T section is not in use. Not clear from the diagram is the fact that the two poles of any particular switch are connected at the input and output, respectively, of each attenuator section. Because of this, it is necessary for these to be as little capacity as possible between the two halves of the switch, because if much capacity exists, the signal can feed through these capacities to the output of the section, reducing the amount of attenuation, and therefore the calculated accuracy. It is for this reason that the arrangement of Fig. 5 is used only for audio frequency work, and never for R.F. In addition, it is usual to have such stepped attenuators at as low an impedance as possible, because then the stray capacities have less effect, and the attenuator is good up to a higher frequency than it would be if the impedance were higher.

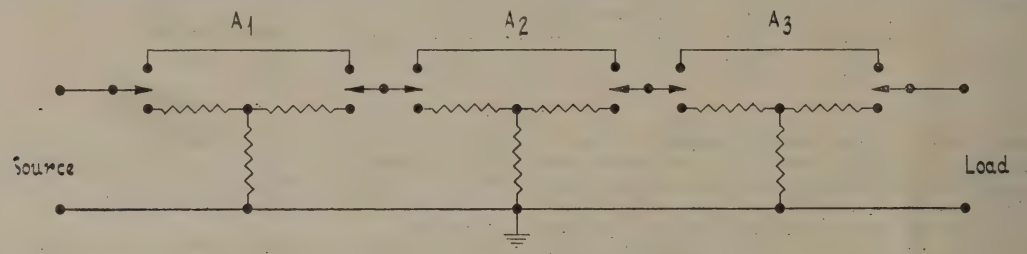


Fig. 5

In Fig. 6 is yet another arrangement which is very suitable for use as the output attenuator of an A.F. signal generator. There is no necessity to have three sections, and for many purposes, two will do. Each section attenuates ten times, or 20 db., and the load is a potentiometer of total resistance equal to R_o. The wafer type switch, which is a ganged control, connects the potentiometer to the output of any section, and at the same time cascades the sections. In the example shown, it is possible to have full output of the oscillator applied to the pot., or voltages of 1/10, 1/100, and 1/1000, depending on the switch positoin. Then, on the potentiometer, a 0–10 calibration can be used, so that the whole arrangement makes possible continuous variation from zero to the full oscillator output. This scheme was incorporated in the "Radel Audio Signal Generator" described in the

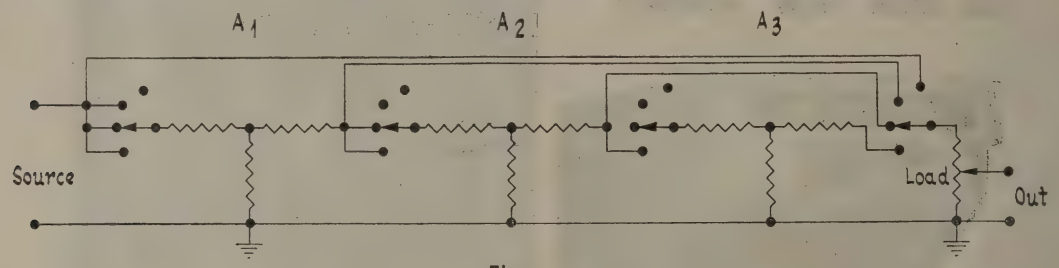
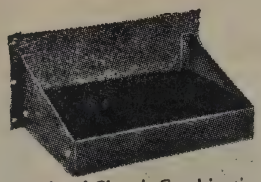


Fig. 6

(Continued on page 48.)

★CHASSIS ★CABINETS ★RACKS



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CHASSIS AND PANEL COMBINATIONS

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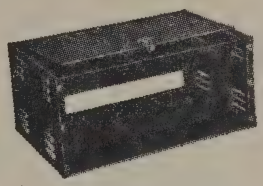
15 in. x 9 in. x 3 in.	£3 5 0	£2 19 6
12 in. x 8 in. x 2½ in.	£2 15 0	£2 10 0
9 in. x 7 in. x 2½ in.	£2 5 0	£2 0 0

Postage Included.



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"Magnaphone"

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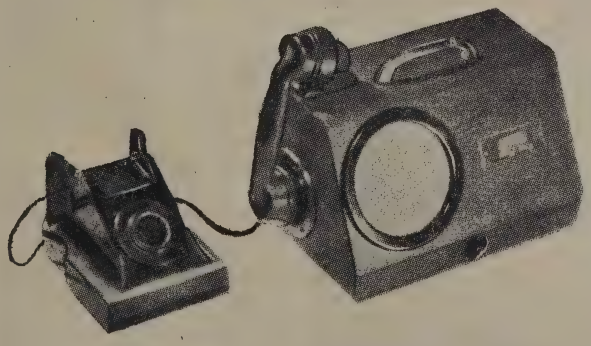

"MAGNAPHONE" is a simply operated amplifier suitable for use with the ordinary telephone. An amplifier that enables users to benefit from the time-saving advantage of having BOTH HANDS free to make notes, etc.

Enables two-party conversations to be turned to a business conference or a family "get together." Requires no installation. Just plug in to a wall socket. Also available for battery operation. Is fully guaranteed.

Immediate privacy of conversation can be obtained if desired by lifting telephone handset from "*Magnaphone*." Fully automatic, simple to operate, is portable and compact.

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The PHILIPS Experimenter

An Advertisement of Philips Electrical Industries of N.Z. Ltd.

No. 47: A Compact and Sensitive Grid-dip Meter

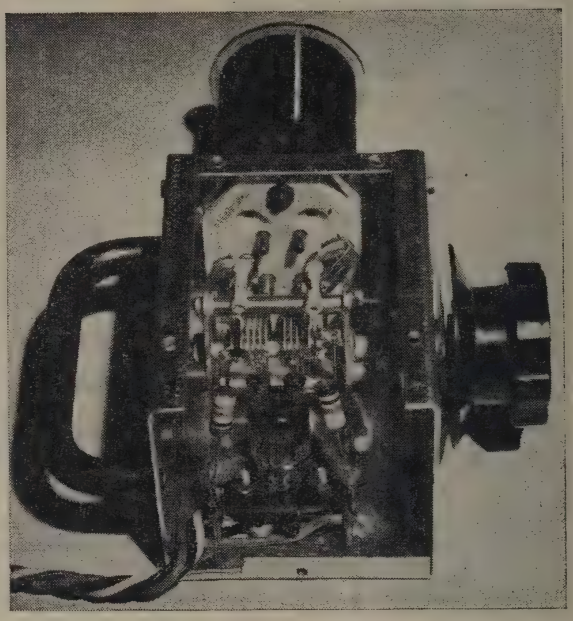
One of the most useful pieces of auxiliary equipment in the "ham" shack or home laboratory is the grid-dip meter. Broadly speaking, it performs most of the duties that an absorption wave-meter can fulfil, but with a very important difference. The grid-dip meter does not require the circuits it is to test to be excited. That is to say, it can indicate the frequency to which a circuit is tuned, even when the gear of the which the circuit is a part is not functioning, and the circuit itself is not handling a signal. Most of us are familiar with the fact that a tuned circuit resonant at the same frequency as an oscillator, can produce a quite violent reaction in the oscillator circuit when it is coupled to the oscillator. It is this that makes it possible to use lecher wires at high frequencies to measure the frequency of an oscillator. The indicator is usually a D.C. milliammeter in series with the grid leak, measuring the D.C. grid current of the oscillator, and when the lecher wires are tuned to the oscillator frequency, a pronounced dip is noticed in the grid current of the oscillator. In this case, the gear being tested is the oscillator itself, but for the purpose, it is being used as a grid-dip oscillator, to indicate resonance in the lecher wires.

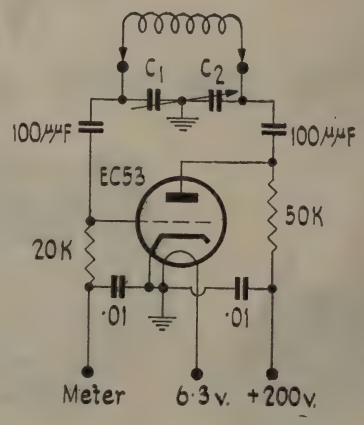
The use of the grid-dip oscillator at lower frequencies is simply an extension of the same principle to lower frequencies. Its most useful role is in adjusting transmitter tank circuits to resonance without the transmitter having to be turned on, and in adjusting experimental circuits, such as coils being made for a receiver, while in situ, but without power applied. In fact, with a grid-dip oscillator it would be quite possible to build a receiver, align it, and have it working, properly aligned, the first time it was turned on! Another useful job for the grid-dip oscillator is in tracking down parasitic circuits in transmitters. This is usually done with an absorption wave-meter, picking up the actual parasitic oscillation, but it is liable to be a dangerous method, especially where high-powered, high-voltage stages are involved. With the grid-dip oscillator, however, the transmitter can be turned off, and one can go poking about in its innards with the grid-dip oscillator without any fear of becoming involved in short-circuits or high-voltage shocks.

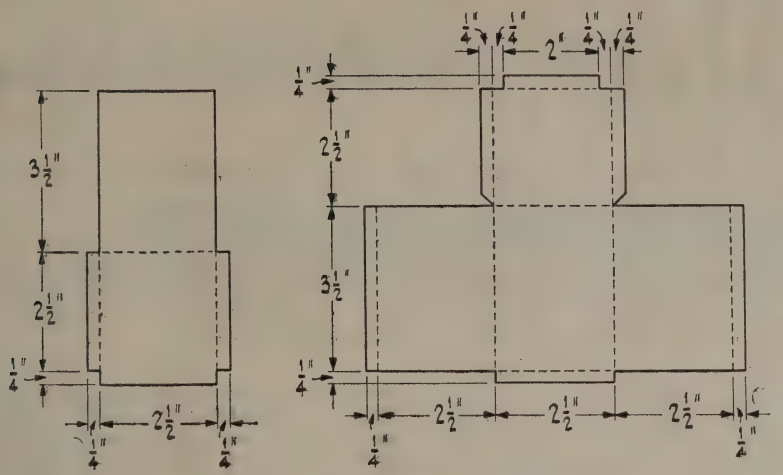
CIRCUIT OF THE OSCILLATOR

The circuit of the grid-dip oscillator is the simplest thing about it. It is a straightforward Colpitts oscillator, using a balanced split-stator tuning condenser. This enables a simple two-terminal coil to be used, and is a great advantage, since builders will mostly want to wind coils to cover a wide frequency range. The tuned circuit is shunt-fed so as to eliminate D.C. from the winding, and to enables coils to be changed without turning off the supply voltages. The grid leak of 20k. enables very lively oscillation to be obtained from the Philips EC53 oscillator tube, and at the same time ensures that the grid current will be large enough to enable a 0–1 ma. meter to be used as the indicator.

The Philips EC53 was chosen for several reasons. Most important of these is the fact that it is specially designed for V.H.F. oscillator service, so that if desired, the frequency range of the oscillator may be taken up to the 144 mc/sec. amateur band, or even higher. With the prototype instrument illustrated here, oscillation could be obtained with a very short "hair-pin" coil as high as 230 mc/sec. This is nowhere near the limiting frequency for the Philips EC53, which will work up to 500 mc/sec. and even higher, but is







simply a limit imposed by the fact that no special precautions were taken to ensure operation in the U.H.F. region. The EC53 is an ideal tube for this circuit, however, because of its construction, with the grid and plate connecters issuing from the top of the bulb, and its heater and cathode pins at the other end. Because of this, it is possible to mount the tube just far enough from the terminals of the split-stator condenser to allow the blocking condensers to be inserted between them. This is very well illustrated in the photograph.

The tuning condenser is a split-stator Polar midget with a maximum capacity of 42.3 $\mu\mu$f. per section, and a minimum capacity of 3.3 $\mu\mu$f. This gives a capacity variation of 39 $\mu\mu$f., and, on the lower frequencies, a frequency range of 1.8 to 1. This high-L circuit is made possible only by the use of the balanced circuit, with the very low minimum capacity of the split-stator condenser, and by the Philips EC53, whose inter-electrode capacities are so small as to limit the maximum-to-minimum capacity ratio hardly at all. A frequency range of this width is very good going, especially with a condenser of such low maximum capacity, and with the Philips EC53 as the valve, it is clear that the factor which does most towards limiting the frequency range is the self-capacity of the coil. The measurement of frequency range referred to was done with the coil illustrated in the photograph, which was close-wound, and must have a high self-capacity.

CONSTRUCTION

In building a unit such as this there are two possible methods of approach. The first is to put all components inside the same small box, so that the instrument is completely self-contained. This was successfully accomplished in the case of the absorption wave-meter which was described in Philips Experimenter No. 33. Here, however, the power supply was from batteries, of the very small hearing-aid type, and even then it was not easy to find space for everything without making the instrument too large to handle easily in use. The present circuit, however, must have an A.C. power supply, since the Philips EC53 is a heater-cathode valve, so that if any attempt were made to cram power supply, meter, and all into the one box, the convenience of having everything under one roof, as it were, would be well outweighed by the bulkiness that would result. One essential of the grid-dip meter is that it should be capable of being poked into small corners of already-built equipment, and to make this possible, it was decided to make the instrument in two units. The "head" contains only the oscillator circuit, and by this means has been kept to very small dimensions, even with the dial and its mechanism included. The coil, of course, is plugged into a socket on the front end of the small box, and it will be noted that the actual winding has been kept at the far end of the coil former. The coil winding itself is really the "business end" of the device, and placing it in this way enables it to be inserted into spaces where it could not otherwise be put. The rest of the instrument (i.e., the power supply and the indicating meter) are built separately, and attached to the head by a cable about a yard long. The only leads carried out from the head are heater and H.T. leads, together with the "hot" meter lead. This lead carries only D.C., so that having the meter at a distance in no way affects the performance of the oscillator. It will be noted that the lower end of the 20k. grid leak is bypassed to the chassis of the head, so that no R.F. should be found on the meter lead. In practice this can easily be demonstrated by handling the cable, when no shift in the meter reading occurs, nor is there any effect upon the oscillation frequency. The control which varies the oscillator plate voltage has been incorporated so that builders will be able to use either a 0.1 ma. or a 0–500 μamp. meter, as desired. In the case of the latter, considerably less plate voltage will be needed to keep the meter needle on the scale. The control is also helpful at the higher frequencies, where the grid current is not quite so great as at lower ones, and it may be desired to increase the meter reading somewhat, before making use of the instrument. Since the construction of the power supply unit is in no way critical, we have not bothered to take up valuable space by illustrating any particular style of unit. The construction of the head is made quite clear by the chassis diagram and the photograph, and is simple in the extreme. In order to keep dimensions down, it was decided not to use one of the small Eddystone dials, since these take up rather too much room when placed on a split-stator condenser, and this would have made the head inconveniently wide. Instead, one of the currently available small planetary drive units was used, and a scale and pointer were made to go with it. It is this that has enabled the width of the chassis to be kept down to a bare 2½ inches. The method of mounting the condenser and the drive unit will be of interest to anyone wishing to duplicate our own original. The condenser was mounted by three bolts, screwing into the ready-threaded lugs placed for the purpose at the back end of the condenser. The back plate of the condenser is kept at a distance of $\frac{3}{8}$ in. from the side of the chassis by small distance-pieces of that length, made from a length of

(Continued on Page 32.)

Wellington Radio Traders' Association

The Annual General Meeting was held at the office of the Secretary, 22 The Terrace, Wellington, when a large muster of members attended. After the routine business was disposed of, members present found much to discuss and there was no lacking of new business, the chairman, Mr. W. Young, being kept on his toes seeing that all had a fair share of the discussion. It can well be claimed that it was the most busy and interesting Annual Meeting held for some years. Starting promptly at 7.45 p.m., the last business was disposed of at 10.20 p.m.

Mr. J. Fairclough, President of the New Zealand Radio Traders' Federation, spoke of the benefit of the recent conference of traders at Chateau Tongariro and reminded those present that if for no other reason his presence at the Wellington meeting was an assurance that the Federation was 100 per cent. behind the local Association. As President, he received copies of correspondence of the Federation and was, therefore, up to date with local problems and this meant that he was able to advise the executives of the Federation of matters of mutual interest at all times. Mr. Fairclough briefly told of the Federation's activities in connection with recent matters including problems of battery supplies, imports of components, etc. The job the Federation was doing was a big one, but it was being done well and if ever the Association fell away from it, the industry would be in poor shape. In stressing the need for greater retailer attendance at Association meetings, Mr. Fairclough said that the wholesaler could not get on without the retailer, both needed each other. All members should support the idea of closer co-operation in this respect by members of the Federation.

Mr. W. Young, in speaking on his annual report (this report was published in *R. & E.* August issue) called attention to the need to expand the activities of the Association and urged members present to send in suggestions and ideas. He stressed the need to enlarge the membership and suggested that present members should preach the gospel of the Federation to others eligible for membership. He stressed the point that although a preponderance of wholesalers usually attended the meetings it was as much a business of the retailer to be present as others, and assured all retailers that their interests would always be catered for by the Association.

Mr. D. B. Billing advised the meeting of the efforts being made by the membership committee of the Association, whose activities were bearing good fruit. There were signs that the attitude of certain retailers, who felt there was little or no need to join the Associations, was being broken down.

Mr. L. Jenness said he believed that many members of the trade would join up but were ignorant of the Association's real work, and suggested that distributors on their calls to dealers might do some propaganda work in this respect.

Federation Badge

It was reported that the circulation of the official badge was an accomplished fact and evidence of this could be seen on traders' premises, but it was apparent that some dealers had not yet found the time to place the badge in position. An imprint of the badge reproduced for advertising purposes and letterheads was passed round for inspection and most members present ordered printing blocks for their own use.

Batteries

It was reported that the Federation had the matter of lack of supplies in hand; the time for objection to the delicensing proposals did not expire until 10th August, and the Federation was objecting to the continuation of licences for importation of batteries.

Television

A long discussion ensued on the problem of trained personnel, one member emphasizing the need for quick action in drawing up a scheme for training. Another member stated that manufacturers and traders could get together and bring out equipment and set up a school, whilst another thought that if it was not done by those directly concerned here the overseas manufacturers would set up a scheme for such training. The discussion culminated in the passing of a resolution referring the matter to the Federation, and recommending that consideration be given to TV in all its phases, with particular attention to the training of personnel.

Meetings

That future meetings might take on an atmosphere of interest in matters other than routine trade problems, was a suggestion that found favour with the meeting and it was resolved that a special meeting be called of particular interest to retailers, and that some officers of the P. and T. Department be invited to give a talk on interference and steps taken to reduce it.

Official Journal

That the magazine *Radio and Electronics* be reaffirmed as the official journal of the trade was unanimously approved. Thanks were passed to the publishers for the publicity this magazine had contributed on behalf of the industry.

A cordial vote of thanks was passed to Mr. Fairclough for making the special trip from Napier to attend the meeting, and Mr. W. Young was accorded hearty thanks for his able handling of the meeting.

Officers elected for the ensuing year were:—

President: Mr. W. L. Young.

Executive: Messrs. D. B. Billing, J. S. Oxley, L. D. Jenness.

Delegates to the Federation: Messrs. W. L. Young and D. B. Billing.

Secretary: Office of the N.Z. Employers' Federation.

Auditor: Mr. Gordon Berry.

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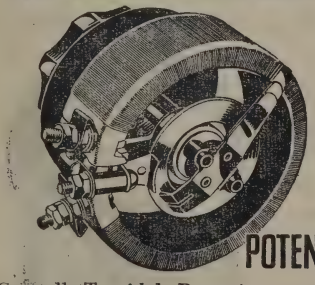

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The 1951

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PERSONAL NOTES

LEADING RADIO FIGURE TRANSFERS TO AUCKLAND

Brigadier S. D. Mason, C.B.E., E.D., A.RA.N.Z., J.P.

The Wellington radio industry recently lost one of its most highly respected members in the person of Brig. Mason, who, on account of prolonged ill-health, was forced to resign from the Secretary-Managership of the Swan Electric Company, Ltd. "The Brig"—as he is so widely known—has taken up residence in Auckland where it is thought that the warmer climate will assist him in making a quicker recovery from his recent very serious illness. He has taken up an appointment in the Head Office of the Swan Electric Company in an advisory capacity to the Managing Director, Mr. William J. Blackwell.

Brigadier Mason, who has had a brilliant career, was born in New South Wales in 1892, coming to New Zealand at the age of seven. He was educated at Marist Brothers and Timaru Boys' High School, and also by the rugged McKenzie country where he was engaged in farming pursuits until the outbreak of World War I. In this war he served as a Trooper in the Canterbury Mounted Rifles, with the Machine-gun Squadron, and in 1917 was commissioned in the Royal Flying Corps. A very severe crash ended his flying career and he turned to the Somerset Light Infantry leaving again for New Zealand to join up with the Territorial Forces in 1920.

At this stage he left the Regular Forces and because high prices and lack of capital debarred him from re-entering the farming industry, he qualified and practised as a public accountant in Timaru until the outbreak of World War II. There he gave more of his life to serving the public, both as a member of the Timaru Borough Council and also the Timaru High School Board of Governors.

Brigadier Mason again served with distinction throughout the whole of World War II, mostly in New Zealand, but for a time in the Middle East. He was Commander in turn of Burnham Military Camp, the 10th Brigade, and 3rd Brigade Groups. His first association with the radio industry came during the latter part of the war when he joined the Ministry of Supply as Assistant to the Controller of Radio Production. Here his job was to act as a liaison officer between the producer and the Controller, particularly with the ZC1 army contract, and with his ability to readily master new subjects, it was not long before he became a widely recognized figure in the radio and allied industries.

In 1946 he joined the rapidly expanding Swan Electric Company, Ltd., as Secretary-Manager, being second-in-command to Mr. N. W. Swan. There were many occasions when he controlled the destinies of the Company for long periods, during the absence aboard of Mr. Swan and later of his successor, Mr. W. J. Blackwell. There is no question that much of the progress of the firm is due to the untiring efforts of Brig Mason. In his position he has earned the confidence and respect of all with whom he has been associated. We are sure that all will sincerely wish that the change to the warmer Auckland climate will quickly speed his complete recovery.

Do you keep your copies of "Radio and Electronics" in binders? If not, please see advertisement elsewhere in this issue.

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MULTI-CORE SOLDER

Containing 3 cores of non-corrosive Ersin flux.

The 7 lb. REEL Ideal for the Radio Serviceman . . . saves time and increases efficiency.

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Telephone 54-695 Telegrams: "RADOGEN"

Prominent Australian Talks on "Impact of Television"

Speaking at Perth in June, Mr. A. P. Hosking, Merchandising Manager of A.W.A., was very optimistic about the continuance of healthy sales of sound broadcast receivers in spite of TV coming.

As Mr. Hosking has been a frequent visitor to New Zealand and is widely known in the trade here his remarks will be of added interest on the subject of TV supplanting sound broadcast, and serve to remove the last shadow of doubt that present and future radio sales will drop because of TV prospects, provided, of course, that the dealer himself does his part in educating his clientele. Mr. Hosking said:

"As an individual who has spent more years than I care to recall in the merchandising field, you may imagine my outlook is that of a born optimist who could be accused of unwittingly glamourizing the future. Rather than lay myself open to such a charge, I intend taking as the basis of prediction facts and figures collated from American statistics and, in turn, applied to Australian conditions, so that as accurate a forecast as possible may be made of the future potential that still offers in the Australian arena.

"When television first loomed on the Commonwealth horizon, it brought in its train a host of dismal prophets. These disciples of gloom foretold the total eclipse of radio at the hands of television, a sentiment which was accepted by far too large a section of the industry in 1949 when it became known that radio production in the U.S.A. had, in the previous year, dropped by three million sets.

"Those of us who did not accept this view were accused of 'whistling in the dark' although, for the life of me, I cannot understand why the appearance of a new product, showing every indication of eventually entering every home (such as radio has done) should be the signal for crepe-hanging.

"The falling-off in production in America during 1948 was no doubt responsible for this dismal outlook, an outlook which cannot be justified after examining figures over the period of years.

"As qualification for this viewpoint, let us first consider what might be accepted as a normal trading year, one unaffected by the diversion of plant for war purposes, such as the year 1939. In that year, production of sound broadcast receivers totalled some 10 million units. Next, as a matter of comparison, let us pass on to 1946, remembering that the intervening years must rightly be ignored due to the interference caused by the war effort.

"In 1946, we find that production in the States had risen to 14 million units. This resulted from a special effort made by manufacturers to take up the backlog caused by non-production in the war period. In 1947, when television really began to gain momentum, sound broadcasting had its all-time peak of 17 million sets.

"In 1948, statistics reveal that the industry received a set-back when production fell by three million, and by 1949, sales had fallen to 11 million sets, a figure which, incidentally, was a mere one million in excess of the best pre-war year.

"In 1950, the most interesting year in radio—one during which TV production had reached the staggering figure of 800,000 sets per month—there were no less than 14 million sound broadcast receivers manufactured and sold, a figure only exceeded in the peak year of 1947, when the industry when making a valiant effort to meet the demand created by the non-productive war period.

"Progressing now to the first quarter of 1951, it is found that this escalation in manufacture continued, for in the January/March period the production of sound broadcast receivers had advanced by 27 per cent. over the corresponding period in 1950, whilst television was 37 per cent. ahead of the previous year. If, therefore, this production rate is maintained, then its average of four million radio receivers in the first quarter is obviously indicative of a total market requirement of 16 million for the current year.

"Having gained some appreciation of the enormity of the market which still offers in U.S.A., let us next very briefly survey the position from the aspect of the number of sets in use and the known population at the end of 1950, in order that we may make a worthwhile comparison of what might be expected in our own country. It is found that there are some 101 million radio sets in American homes as against a population figure of 152 million—in effect, there is more than one set to every two persons. Next, let us compare this analysis with the known Australian licences of two million receivers in the hands of eight million people—in other words, one to every four persons. Now we begin to realize the wisdom or otherwise of those dismal prophets who waved their shrouds and said . . 'Worse to come!'

"From the foregoing analysis of sales development in U.S.A., it will be gathered that the development that has taken place there and will repeat itself in Australia

(Continued no page 47.)

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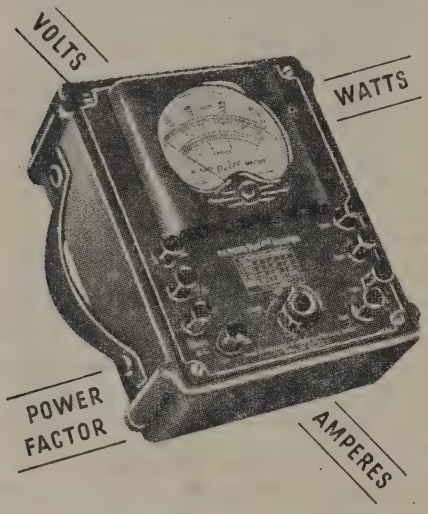
NEW PALEC MODEL PA POWER ANALYSER

Stockists Swan Electric Co., Ltd.



The Palec A.C. Power Analyser, Model PA, Australia's first dynamometer multi-meter, for electrical service, maintenance, and testing.

Ranges:

VOLTS A.C.-D.C.	AMPERES A.C.	WATTS A.C.
0—125	0—1	0—10,000
0—250	0—5	9 ranges of watts
0—500	0—20	3 for each voltage range

POWER FACTOR: $\frac{\text{Watts}}{\text{Volt. Amperes}}$: Rotary switch

POWER CONSUMPTION: Negligible.

ACCURACY: Effects of wave form, power factor, voltage, current, and frequency variations are negligible.

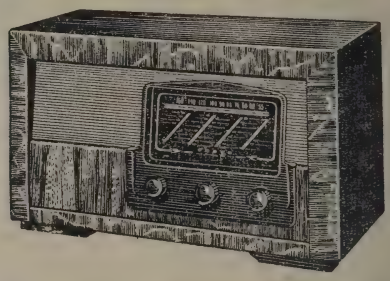
The Palec A.C. Power Analyser incorporates a true dynamometer movement of the nickel-iron cored type. There are no rectifiers or non-linear resistances included, nor is it necessary to compensate for line voltage in wattmeter readings.

APPLICATIONS: Industrial maintenance, production testing, laboratory work. Particularly suitable for testing and servicing refrigerators and other motorized appliances. D.C. or well as A.C. voltage may be measured.

EXTRAS: Leatherette-covered carrying case, external resistance box of 3-phase testing and current and potential transformers for extending ranges supplied at extra charge.

DIMENSIONS: The Palec Power Analyser is housed in an exclusive semi-hard rubber case, size 8 inches by 9¾ inches by 4½ inches overall. Weight, 8 lb.

NEW "ULTIMATE" RECEIVERS



The illustration here shows the new "Ultimate" 6-valve broadcast A.C. receiver, the 6-valve dual-wave A.C. receiver and 6-valve dual-wave vibrator model.

These three "Ultimate" models are housed in a cabinet built on semi-severe lines, softened by the dial and moulded control panel escutcheon. Simplicity of design with medium wood tonings allow for harmonizing with home furnishings.

The new trend in dial calibration with a 5-position tone-switch indicator, allows easy tuning and maximum station coverage.

Full provision is made on the chassis for extension speakers and for use of records where a separate gramophone unit is desired.

All three models are excellent performers on broadcast wavelengths and clear trouble-free short-wave is given on the dual-wave and vibrator models.

Extra power over and above the usual needs allows for difficult areas.

Retail Prices:

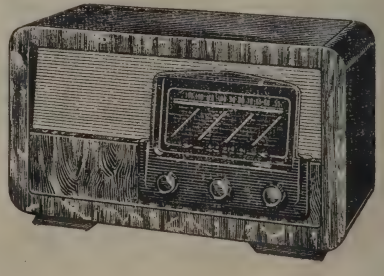
6-valve broadcast A.C.: £39 17s. 6d.

6-valve dual-wave A.C.: £48 15s.

6-valve dual-wave vibrator: £60 19s. 6d.

A CORRECTION—ULTIMATE RADIO

In the New Products Section of our August issue the wrong illustration inadvertently appeared for Ultimate 5-valve Broadcast Mantel and 6-valve Broadcast Vibrator receivers. We print below the correct illustration and we regret any confusion which may have arisen.



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- Recessed hanging ring incorporated in base cap.
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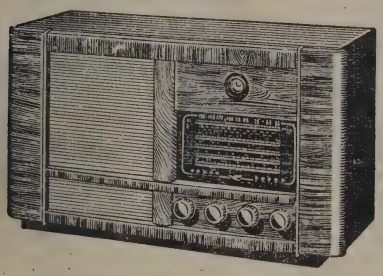
IMPORTANT DEVELOPMENT OF NEW MATERIAL WITH PERMANENT MAGNET PROPERTIES

One of the problems facing manufacturers of radio and television sets throughout the world is the serious shortage of the strategic metals nickel and cobalt, which are extensively used in the manufacture of modern high quality permanent magnets.

Philips, who pioneered the use of permanent magnets in loudspeakers, and whose research laboratories developed the magnet steel "Ticonal" which is used all over the world, have today announced that they have found a new magnetic material which is outstanding for its quite new and interesting properties.

The new material is extremely suitable for the manufacture of permanent magnets as well as having the advantage that the raw materials required can be obtained much easier than the scarce and costly metals, nickel and cobalt.

The new magnetic material is at present being manufactured in the Philips factories and will be available to a limited extent in 1952.



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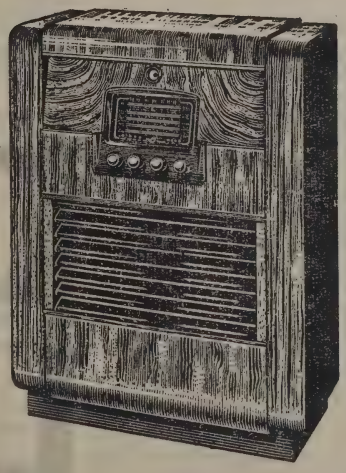

A wide range of Ultimate models offers a choice for every need. From 4-valve Broadcast to 10-valve Bandspread All-wave Consoles, each is in a class of its own. Your nearest Ultimate dealer will be glad to demonstrate for you.

Manufactured by

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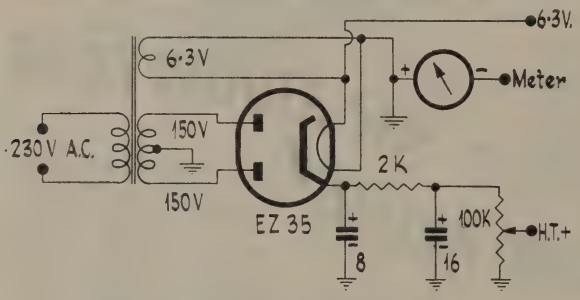
Philips Experimenter

(Continued from Page 24.)

¼ in. copper tubing. This three-hole mounting makes a firm support for the condenser, so that there is no need to rely on support at the front end. Here, the planetary drive unit is attached to the condenser shaft in such a way that the large (9/16 in.) shaft, which moves at condenser speed, comes through a ⅝ in. hole in the side of the chassis. The home-made pointer is attached to this part of the mechanism, and the operating knob is put on the ¼ in. shaft so that it does not foul the pointer as they both rotate. Care must be taken to see that the drive mechanism comes far enough through the hole to allow the pointer, when attached, to clear the head the bolt that must be put through close to the shaft, to hold the planetary mechanism stationary. Alternatively, a countersunk screw can be used so that the question of clearance does not arise.

The pointer is made in three parts. The pointer proper is made from a small piece of celluloid sheet, with a radial scratch to act as the cursor. The celluloid is broadened out towards the shaft end so that a 9/16 in. hole can be made, and the pointer slipped over the large shaft of the drive. To attach the celluloid to the shaft, two washers are made of thin tin. Both of these have a 9/16 in. hole, like the celluloid, and the three are made into a sandwich. Three lugs



Power Supply and Indicator Circuit.

are left on one of the washers, and when the three bits are assembled, these are bent over, clamping the celluloid firmly between the two washers. The whole thing is then slipped over the shaft, and the outer washer is spotted on to the shaft with solder. It is necessary to tin the shaft beforehand, and to perform the soldering operation quite quickly so as not to allow the celluloid to melt, let alone to start burning. A paper scale, reading 0–100 is then pasted on to the side of the box, under the pointer. It is not practical to attempt to make the instrument direct reading, because of the small amount of room that is available. Calibration charts can be drawn for use with the dial readings, and for the limited frequency accuracy that is needed for an instrument of this sort, the charts need not be made with very great care.

USING THE METER

If the circuit to be tested is fixed-tuned, the meter is brought close to it, and the dial is slowly rotated, taking care to keep the head as still as possible. When the test circuit's frequency is tuned through, a very pronounced dip will occur, and there will be no possibility at all of confusing this with the very gradual change in grid current that occurs as the oscillator is tuned from one end of the band to the other. If the test circuit is tunable, then the grid-dip oscillator may be set to the required frequency, and the test circuit tuned to see if or where it hits the oscillator frequency. It will be found that when the test circuit is a good one, with a high Q, the coupling can be very loose indeed while still being great enough to make a pronounced flick as it is tuned through resonance. For initial spotting, the coupling can be tight, but if it is desired to take a reading as accurately as possible, the coupling should then be reduced to the minimum that will allow an estimation to be made of the exact point of the dip. The reason for this is that when the coupling is tight, the circuit will pull the oscillator, and this pulling is least when the coupling is as loose as possible. The reason for the dip in grid current is to be found in the fact that the test circuit absorbs power from the oscillator circuit, and this in turn reduces the effective degree of feedback, so that the grid current decreases.

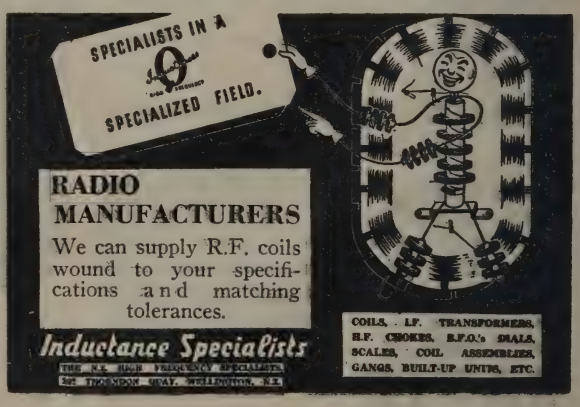
WINDING THE COILS

The coils are wound on six-pin plug-in polystyrene coil formers. The low-frequency coil uses a former of 1½ in. diameter, while the others are all wound on the smaller 1¼ in. formers. The winding data are as follows:—

Band.	Wire.	No. of Turns.	Spacing.
3–5.4 mc/sec.	28 en.	70	Close wound.
5–9 mc/sec.	28 en.	40	Close wound.
9–16 mc/sec.	28 en.	19	Close wound.
16–29 mc/sec.	28 en.	11½	Spaced to length of 9/16in.
28–51 mc/sec.	28 en.	6½	Spaced to length of ⅝ in.
50–94 mc/sec.	28 en.	2½	Spaced to length of ⅜ in.

It can be seen from the table that as the coils become smaller, and space-winding is employed, the frequency coverage becomes slightly greater, owing to the reduction in the self-capacity of the coils. Slight adjustments to the inductance of the smaller coils can be made by spreading or squeezing the turns slightly, so that overlap with the next largest coil is just obtained. Since great accuracy is not required, the coils can best be calibrated with the aid of a calibrated receiver as long as care is taken to see that the receiver is not tuned to an image when the oscillator is received on it. Those fortunate enough to possess a BC211 or equivalent frequency meter will have no difficulty in calibration, but even then, the receiver should be

(Continued on page 48.)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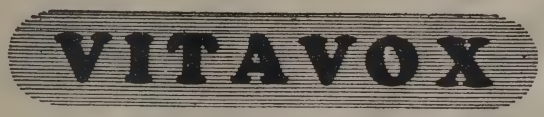

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THE "RADIO AND ELECTRONICS" ABSTRACT SERVICE

AUDIO EQUIPMENT AND DESIGN

A method of audio frequency measurement and spectrum analysis described, using only audio oscillator and oscilloscope. The signal to be measured is connected to the paralleled inputs of high-pass and low-pass filters and it is possible to measure several frequencies simultaneously, and make a spectrum analysis.
—*Audio Engineering* (U.S.A.), May, 1951, p. 22.

A survey of audio frequency circuits—single ended and push-pull output stages contrasted, and series-balanced output stages arrangements. The nine possible combinations of the two-tube output stage are described in an interesting summary.
—*Ibid*, p. 15.

Improved bass response is probably the most important step in high-fidelity production for the amateur; listeners seem to prefer a restricted frequency band violating the principles of reality, but frequencies from 16 to 16,000 cps seem necessary. The paper deals with mgnetic damping, mass of the voice coil, cone mass, the infinite baffle, also cabinet construction.
—*Ibid*, p. 16.

Instructions are given on how to talk to the microphone and what to avoid, with information on the placing of units and the phasing of the loudspeakers.
R.T.F. Service (U.S.A.), February, 1951, p. 33.

An excellent article on the development and the principles of tape recording.
—*Radio and Hobbies* (Aust.), July, 1951, p. 36.

CIRCUITS AND CIRCUIT ELEMENTS

No condenser is pure capacitance and the plates must have some inductance so each condenser has L and C in series, and is resonant at high frequencies. This may have unexpected results but the fact can be made use of in TVI by-pass circuits by resonating for minimum impedance.
—*Q.S.T.* (U.S.A.), April, 1951, p. 14.

The design of input regulation control chokes, the principle of action being an arrangement for the variation of L over a range of current values so as to improve regulation of the supply.
—*Electronic Engineering* (Eng.), May, 1951, p. 179.

ELECTRONIC DEVICES

Aircraft navigation instruments—many of the instruments used by aircraft navigators are described here, designed to be direct reading, unambiguous and accurate.
—*Electrical Engineering* (Eng.), May, 1951, p. 384.

The highest frequency for a conventioned CRT is about 10 mc/sec., but an artifice makes it possible to reach much higher frequencies. Stroboscopic flashes of light are replaced by electric pulses which scan the voltage curve to be examined.
—*Philips Technical Review* (Holland), August, 1950, p. 52.

There is a large field for the services of blind technicians in radio servicing if instruments with audible indications are devised. The paper is fruitful of ideas that might extend a new field of usefulness to the blind.
—*QST* (U.S.A.), April, 1951, p. 26.

An amplifier for use in physiology suitable for reading human and animal electro-retinographs. This is a reasonably simple circuit and gives its readings on a CRT.
—*Electronic Engineering* (Eng.), May, 1951, p. 171.

A brief review of the operating principles of stroboscopes with the circuit and method of control.
—*Ibid*, p. 177.

A very full and interesting study of the Philips 100 kv electron microscope.
—*Philips Technical Review* (Holland), August, 1951, p. 33.

MATHEMATICS

The design of filters can be had from simplified formulae without resort to charts or tables. The method consists of estimating the centre frequency of the band-pass and calculating the value of the L and C elements.
—*Audio Engineering* (U.S.A.), May, 1951, p. 26.

Coaxial stubs can often be effectively used in a transmitter or receiver to reduce or trap spurious radiations. Graphs give approximate stub lengths for interfering frequencies in various ranges.
—*Electronics* (U.S.A.), June, 1951, p. 132.

MATERIALS, VALVES, AND SUBSIDIARY TECHNIQUES

Many problems require the conversion of electric variations to that of light intensity to respond to audio frequencies. A cold cathode glow discharge tube is described which will perform this function giving a modulated light.
—*Electronic Engineering* (Eng.), May, 1951, p. 167.

A development of the high-powered klystron which meets the problem of high power up to some 890 mc/sec. The valve described is capable of 5 kilowatts and is an important development of the low-powered prototype.
—*Electronics* (U.S.A.), June, 1951, p. 108.

Fluid mappers are liquid flow devices for visually simulating electrostatic, electromagnetic, and heat deductions, etc. It is not difficult by the process mentioned to demonstrate electric stresses in a striking manner.
—*Wireless Engineering* (Eng.), May, 1951, p. 396.

A simple and inexpensive process for resharpening sapphire and other recording styli has been revealed. The method involves immersing the stylus in sodium hydroxide instead of regrinding.
—*Ibid*, p. 447.

PROPAGATION

In the early days of radio it was observed that conditions were poor when aurora appeared. At the beginning of a storm there is an abrupt change in the earth's magnetic field and the effects are now being studied by radar soundings.
—*QST* (U.S.A.), June, 1951, p. 14.

An important article for the designers of U.H.F. and S.H.F. systems. A series of graphs are supplied for determining the suitability of a location for the propagation of waves in relation to the terrain. Free space attenuation, topographical, and atmospheric conditions and absorption are taken into account.
—*Electronics* (U.S.A.), June, 1951, p. 116.

RECEIVERS

A design of a very neat little three-valve set suited to young builders stated to have excellent performance.
—*Radio and Hobbies* (Aust.), July, 1951, p. 48.

A major problem in multiplexing channels is the mixing of the intelligence and identifying it again "at the other end." A pulse width discriminator is detailed which will handle very narrow pulses with stability and simplicity of operation.
—*Electronics* (U.S.A.), June, 1951, p. 105.

TELEVISION

A detailed and simple explanation of the R.F. and I.F. amplifiers in a TV set—deals with the matching of the antenna to the input, the R.F. stage and the properties of R.F. amplifier-oscillator arrangements and the traps for the sound carrier, with notes on defects that may arise.
—*Radio Television Electronic Service* (U.S.A.), February, 1951, p. 22.

The manufacture of TV receiving antennas is quite an involved business. There are questions of the right aerial for the site, problems of matching impedances and of stacking, also production technique.
Television Engineering (U.S.A.), February, 1951, p. 8.

Mathematical concepts of differentiating and integrating illustrate vertical sweep synchronism pulses and pulse separation, also the operation of the thyratron saw tooth generator.
—*Ibid*, p. 14.

Perspective distortion in TV pictures. The paper deals with selecting the camera field angles, perspective discontinuity of composite scenes and criteria for picture definition.
—*Ibid*, p. 19.

Fast acting AGC for TV circuits of a kind known as keyed AGC is now developing. The rectifier is made to conduct only for a short duration of the keying pulse supplied at the horizontal sweep frequency which reduces susceptibility to noise.
—*Radio Television and Electronic Service* (U.S.A.), February, 1951, p. 36.

TRANSMITTERS AND TRANSMITTING

The article outlines the method for arriving at suitable operating voltages and currents for double sideband reduced carrier telephony. Circuit details given for a 75-metre transmitter.
—*QST* (U.S.A.), June, 1951, p. 21.

Surplus low frequency crystals may be used in a standard lattice network to give band-pass characteristics that will greatly help selectivity of communication transmitters and receivers.
—*Ibid*, p. 61.

A very simple design for 2-metre mobile transmitters that can be used for long periods without exhausting the batteries.
—*Ibid*, p. 61.

A transmitter for 576 mc/sec. This appears of great interest to the experimenter and uses a wartime type valve RL18 and parallel lechers provide the tuning. Fundamentally there is nothing difficult about this band if the principles are understood.
—*Radio and Hobbies* (Aust.), July, 1951, p. 65.

A miniature transmitter for 220 mc/sec. with an output of 3.5 watts is described with construction details.
—*QST* (U.S.A.), April, 1951, p. 42.

If the methods outlined are employed crystals for frequencies up to 5 mc/sec. may be used on the overtone oscillator basis without "birdies" or undue trouble.
—*Ibid*, p. 56.

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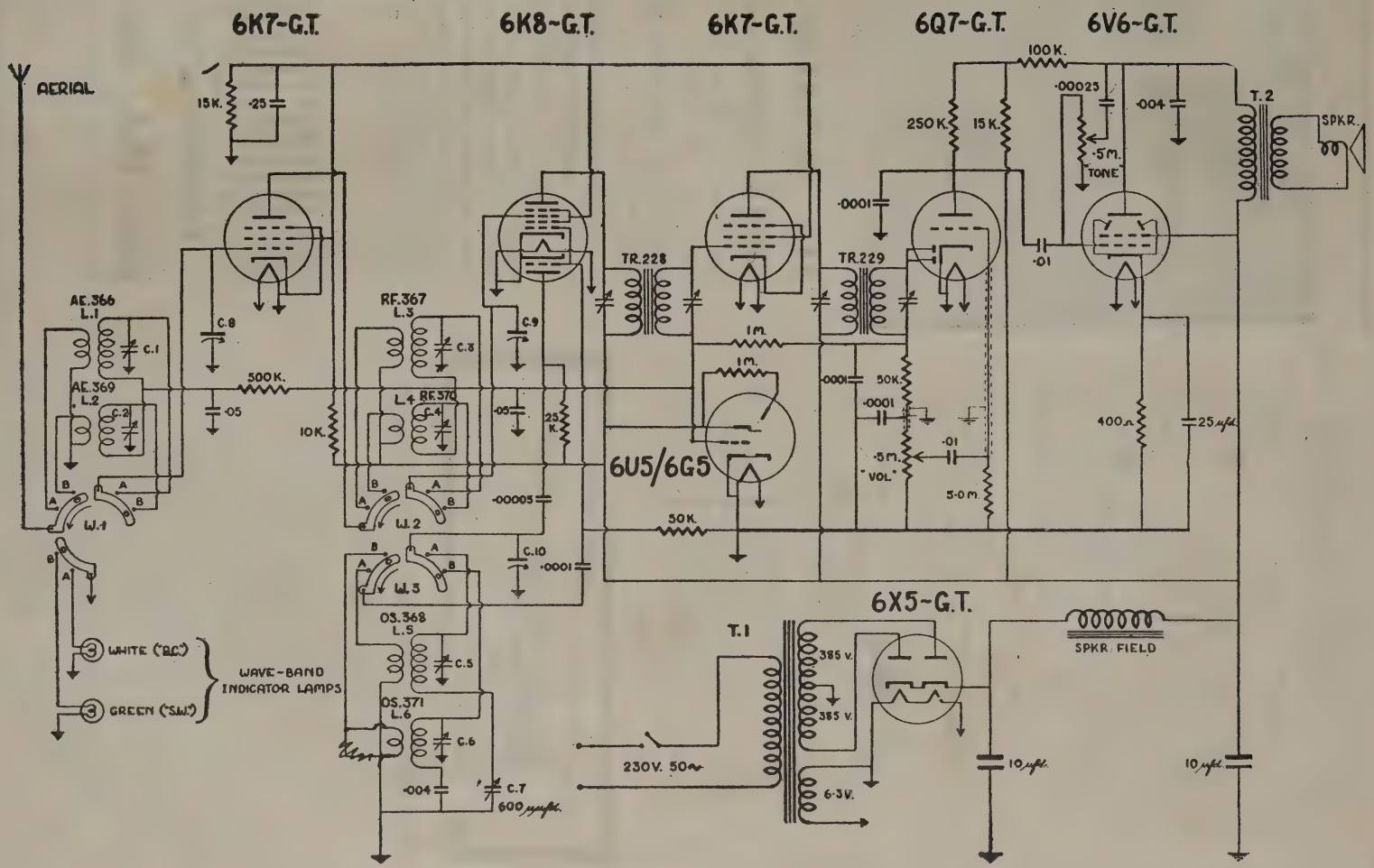

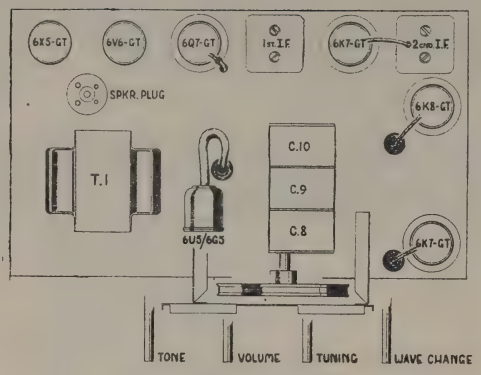

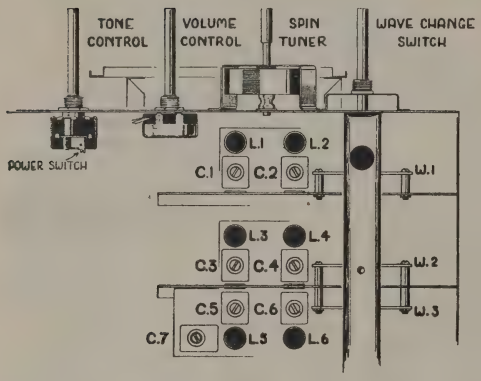

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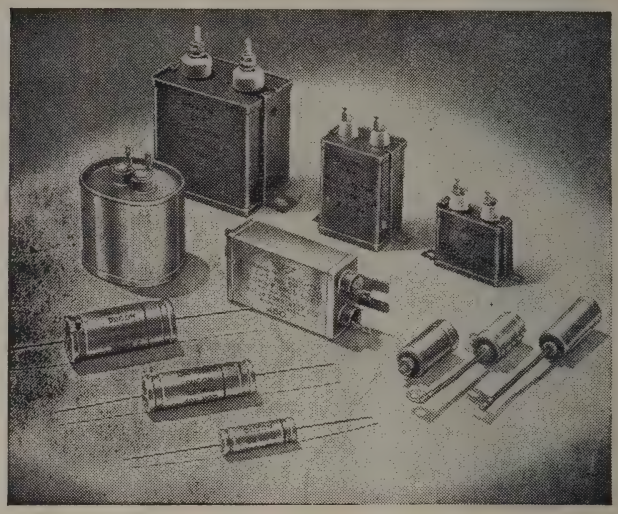
New British Broadcast Transmitter For Sweden

A further contribution to Britain's export drive in hard currency areas is the recent addition to the broadcasting services in Sweden of a "Standard" medium-wave broadcast transmitter at Gothenburg. This transmitter has a power output of 150kW with two radiators giving a directional field pattern with maximum field strength on the landward side and minimum towards the sea.

To minimize interference, the signal is reduced in the direction of N.W. Africa, where a broadcast transmitter is working on the same frequency.

It is interesting to note the growth of Gothenburg station. Built in 1925, it was one of the first radio broadcasting stations in Sweden, and was equipped with a transmitter of 500 watters power; in 1928 it became a 10kW station serving a public of about 400,000 and now in 1951 the new 150kW transmitter is serving about 750,000 of the Swedish population. In each case the equipment was manufactured by Standard Telephones and Cables, Limited, a tribute to British workmanship.



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Television, Today and Tomorrow

By L. MARSLAND GANDER, Radio Correspondent of the "Daily Telegraph" (London)

Despite the switch-over to rearmament, television continues to flourish in Britain more than in any country except the United States. The number of television receiving licences issued is 825,600, and will soon pass the million mark, although only two of the projected chain of five high-powered transmitters are actually working.

A third high-power transmitter, at Holme Moss, near Huddersfield, in the English county of Yorkshire, is nearing completion but has been delayed by bad weather. Others at Kirk O'Shotts, between Glasgow and Edinburgh, Scotland, and at Wenvoe, near Cardiff, South Wales, are in earlier stages of construction. Until rearmament began in earnest it was intended to open the three remaining high-power transmitters by mid-1952, and also to build, by 1954, five low-powered local stations to cover Newcastle, in the English county of Northumberland, Southampton, in the English county of Hampshire, Aberdeen, Scotland, Plymouth, in the English county of Devonshire, and Belfast, Northern Ireland. However, it was announced in March that arms priority would mean indefinitely postponing construction of these five smaller transmitters. The net result is that Britain's television plans, as curtailed, envisage a service for 75 per cent. of the population, or about 37,500,000 people.

The question of the future of television in Britain will be debated shortly in the House of Commons when the report of the Beveridge Broadcasting Committee comes up for consideration. This committee, appointed in 1949 under the chairmanship of Lord Beveridge, has passed what virtually, amounts to a vote of confidence in the British Broadcasting Corporation's system of monopolistic public ownership, though it proposes safeguards. It declared against financing radio or television by any form of advertising, and proposed that borrowing up to £10,000,000 should supplement licence revenue.

FIVE-YEAR PLAN FOR NATIONAL COVERAGE

Approval of the Corporation's five-year plan for national television coverage is implicit, but the committee challenged the Corporation's idea that all studio programmes should be fed to the national network from London. It urged that studios should be provided in the provinces. Other proposals were: Experiments with television in schools; a special Television Programme Advisory Committee; more independence for television within the Corporation's framework by a greater administrative distinction; licensing of organizations for public showing of big screen television (subject to agreement with the Corporation and interchange of programmes); possible raising of the present £2 combined sound and vision licence fee.

Public eagerness for television is shown by the rising graph of sales. Normally the rate of increase declines after Christmas but this year more than 250,000 new licences have been issued since the end of November. Although purchase tax on sets was doubled in the last Budget from 33⅓ per cent. to 66⅔ per cent. there has been no appreciable decline in sales yet. Even with this fresh impost at least three makes are obtainable at about £50.

Progress is not waiting entirely upon completion of the new provincial transmitters. Two new mobile units have been added to the outside telecasting fleet, making a total of five. This has made possible a great increase in the scope and variety of the programmes. Two are being used at London's South Bank Exhibition of the Festival of Britain and the other three are covering respectively Greater London, the South and the Midlands areas. Thus although there are yet no studios in the Midlands where the Corporation's second station is transmitting from Sutton Coldfield, it has been possible to reverse the programme traffic and send shows from Birmingham halls and theatres to London.

TELEVISION NEWSREEL FIRST IN POPULARITY

Overall, the Corporation has increased outside programmes by 50 per cent., and viewers in Britain will be seeing in their homes items ranging from "live" chess to Trooping the Colour, from skating championships to the South African Test matches. Where the mobile units cannot go, for technical reasons, the television newsreel camera men can. They are at present ranging all over Britain and the world. The Corporation has one cameraman in Korea—Ronnie Noble—and regularly receives reels from the National Broadcasting Company in America. There are three editions of the newsreel weekly and it still stands first in popularity.

Programmes which most people would have declared to be "non-visual" have been racing ahead in public favour, namely those involving hard-hitting spoken controversy. Chief among these is "In the News." Two Right-wing and two Left-wing politicians sit on either side of an impartial chairman and verbally attack each other hammer and tongs. Viewers, often angered, nevertheless like it.

Children's programmes, assisted by the acquisition of former film studios at Lime Grove, Shepherd's Bush, London, have also been greatly developed. There are daily "hours" covering juvenile interests ranging from serial stories like "Treasure Island" to competitions, puppet shows, how-to-make this and that, and cowboy films.

Drama remains high in popularity and the major production on Sunday evenings is now a fixed feature of national life keeping millions at home. The adult serial so popular in sound broadcasting, has appeared, with Anthony Trollope's "The Warden," and doubtless many others to follow. Despite all difficulties, television in Britain is heading triumphantly for new heights of popularity and is perceptibly changing social habits.

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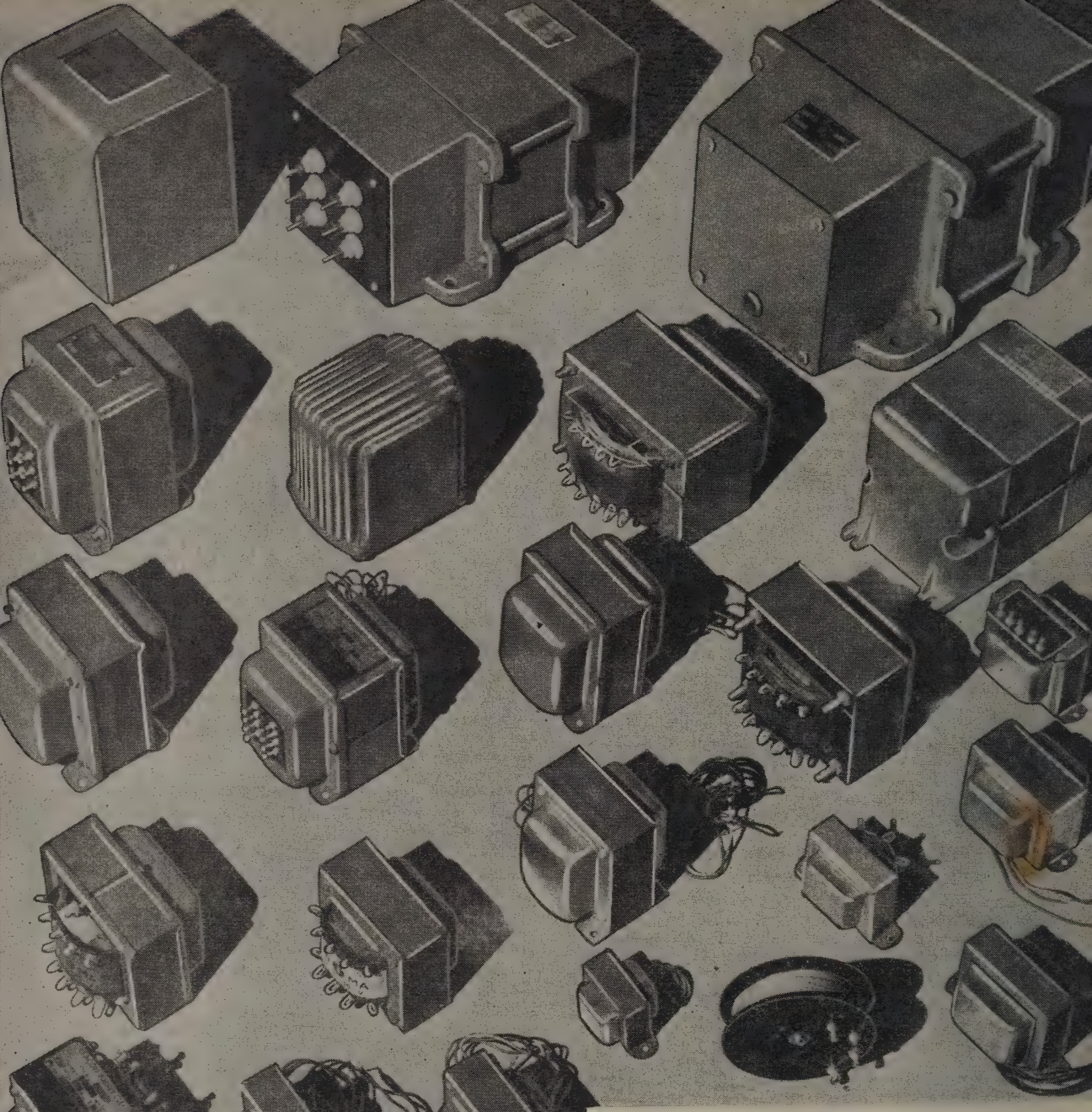

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BEACON RADIO LIMITED

32 Fanshawe St.
AUCKLAND

Amateur 6-Metre Receiver

(Continued from Page 8.)

stable neutralizing condensers are used, and wiring is firm and rigid, the stage will hold its neutralization without difficulty. Needless to say, neutralization of a Class A stage is a little more tricky than that of a Class C stage. This is because the Class A stage passes plate current at all times, and amplifies, too, whereas the Class C stage passes current only in short pulses, when excitation is applied. However, there is a simple method of neutralizing a Class A stage that enables very nearly perfect neutralization to be effected without any instruments other than an output indicator attached to the output stage of the receiver. This will be described later.

In order to realize the greatest possible stage gain from the R.F. amplifier, and to make tracking as easy as possible, the coupling between the R.F. plate and mixer grid circuits is capacitative, with the tuned circuit, series fed, in the plate circuit of the amplifier. The coupling condensers are 15 $\mu\mu$f. each, feeding into 0.5 meg. grid leaks. The oscillator is the very simple cross-coupled push-pull, or kallitron circuit, as it is sometimes called. As mentioned previously, no special arrangements have to be made with this circuit for adjusting the degree of feedback, and only a simple centre-tapped coil is used, without a tickler winding. The circuit is inherently balanced, and as long as the halves of the 6J6 oscillator tube are reasonably well matched, equal R.F. voltages are found at the plates. Also, because of the circuit arrangement, these voltages are automatically 180 degrees out of phase, so that in addition to its simplicity, the oscillator has the great advantage of providing properly balanced injection voltages for the two sides of the mixer circuit. Output from the oscillator is also capacity coupled to the mixer grids, but this time through very small condensers of only 3 $\mu\mu$f. each. The purpose of these is to reduce "pulling" as much as possible, since the oscillator frequency is only 4.5 mc/sec. lower than the signal frequency. Checks taken before the three tuning condensers were ganged up showed that pulling was negligibly small in relation to the bandwidth of the set, and could cause none of the difficult tuning associated with a receiver whose oscillator frequency is pulled badly by the tuning of the signal circuit of the mixer. At the same time, other tests showed that this small capacity was quite large enough for the proper injection voltage to be applied to the mixer grids.

The two-stage 6BA6 I.F. amplifier is quite ordinary, except for its frequency; as an aid to stability, the cathodes of the tubes are grounded. This is a wise precaution in high-frequency I.F. stages, especially where there are two or more of them, since there is then no question of whether or not the cathode circuits are properly bypassed—and this is often a more difficult problem than one might expect at the frequency concerned. Both I.F. stages are controlled by A.V.C., and this is able to be switched off, a manual I.F. gain control being automatically brought into circuit when it is done. It will be noticed that A.V.C. has not been applied to either the R.F. stage or to the mixer. This is not simply because these stages employ triodes, for it is quite possible to obtain excellent gain control in this sort of stage. Since it is expected that a large amount of the work of this set will be done on weak to very weak signals, it is a definite advantage to have the R.F. stage, in particular, running at full gain all the time. It is possible to do this because the grid base of a triode is considerably larger than that of a pentode when the latter is running at maximum gain, so that strong locals are not nearly as likely to overload the triode stage, and A.V.C. can be left off. When A.V.C. is applied to a set handling weak signals, at frequencies where the signal-to-noise ratio is likely to be determined mostly inside the set itself, the signal-to-noise ratio is definitely worse than when the R.F. stage is allowed to work at full gain at all times. We do not pretend that with only the two I.F. stages controlled, the A.V.C. characteristic of the set will resemble that of a broadcast receiver with three controlled stages, including the mixer and R.F. tubes, but the action will be sufficiently good to prevent blasting when the set is tuned over a strong local signal. For fixed-station use, an exceedingly good A.V.C. characteristic is not necessary at V.H.F., in any case, and users will probably find themselves using the manual gain control just as often as not.

The use of an infinite-impedance second detector has already been mentioned in connection with the selectivity of the receiver. It would have been possible to use a pentode plate detector, and to reap the advantage of the considerable audio amplification that takes place in this type of detector, but this was decided against because of the possibility of microphony and audio instability, not to mention the rather high distortion that the pentode detector can produce under unfavourable conditions of signal input and modulation percentage. The quality of the output when the triode is used will be limited only by that of the transmission, and quality reports can be relied upon to be uncoloured by the characteristics of the receiver.

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It may be asked why the diodes in the 6AT6 used as the first audio amplifier have been used as the A.V.C. rectifier, rather than those in the detector tube. There are two reasons for this. First, the infinite impedance detector has its cathode at a relatively high positive potential with respect to ground, and if this diode were used, there would be an A.V.C. delay voltage equal to this potential, which is much too high for the purpose. Secondly, using the diodes in the other tube makes it possible to have them much nearer to the plate of the last I.F. amplifier, which is the point at which it is desired to pick off the R.F. for A.V.C. rectification. It is usually true, and more particularly so in a high-frequency I.F. amplifier, that the greatest I.F. voltage occurs not at the secondary of the last I.F. transformer, but at its primary, so that for most effective use of the signal that exists in the set, the latter is the best spot for picking off the signal. When the layout is examined, it will be seen that the lead from the plate of the second I.F. stage to the A.V.C. diode is very short, due to the placement of the A.V.C. tube. It would only have been possible to do this otherwise by using as the second I.F. tube one with diodes built in, and this was not desired because no high-GM tubes of this nature are available.

The audio and output stages are conventional and call for no special comment.

The B.F.O. circuit is well-known enough, especially as a highly stable V.F.O., but it is not often seen as a beat oscillator in a receiver. It is the ultra-stable Clapp circuit adapted for B.F.O. use. A very nice adjustment is made possible by bringing the large condenser that is connected between cathode and ground, out to the front panel, and making a portion of it variable. It is connected to the rest of the oscillator circuit by means of a long shielded lead, which does no harm, as the capacity of the shielded lead is simply added to the already large circuit capacity. The B.F.O. is remarkably stable, as one would expect, so that any drift in the beat note can be put down not to the B.F.O. itself, but rather to the local oscillator, or the received signal. Indeed, the B.F.O. is so stable that it serves as a very useful check on the stability of the local oscillator, which, while it clearly cannot be expected to be as stable as the B.F.O., nevertheless does perform very well in this respect, and will certainly not cause difficulty in copying stable C.W. transmissions.

Note.—In the next instalment of this article, complete component values will be given, together with a description of how to align the set. Separate aerial coupling arrangements will be described for use with co-axial or open-wire feeders.

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PROMPT ATTENTION GIVEN

Letter to the Editor

Training Servicemen for Television

Sir,—With great interest I have read Mr. Slade's letter in your issue of 1st July, 1951, re training of electronic servicemen generally. It is of great interest to me since I am engaged in developing this work at the Technical College to which I am attached.

I feel that Mr. Slade may be underestimating the part the Technical Colleges can play in the training of radio and TV servicemen. For example, it is unlikely that he is aware of the fact that a two-year course in industrial electronics has been instituted at this college. Further, we have spent a good deal of money on modern servicing equipment and plans to build a modern electronics laboratory have been completed. All our planning in this field has been done with careful regard to future developments.

Further, some Technical Colleges in New Zealand, of which ours is one, are steadily developing into what are known as Technological Institutions; that is, undertaking technical training on a higher plane than hitherto.

These factors surely indicate that the time is rapidly approaching when some degree of co-operation between the radio industry and the colleges will not only be practicable but necessary. By pooling certain basic equipment necessary to TV servicing in the college laboratory, firms could relieve themselves of some of the heavy initial training costs. With their improved facilities, the colleges could perhaps better undertake such training than individual firms.

There are, of course, plenty of precedents for this idea. It is common in England. The Broken Hill Proprietary of Australia has co-operated with the Technical College in Newcastle with mutual benefits. As a matter of fact, the motor trade in Auckland is employing the same idea. The justification from the industry's point of view is, of course, the effective production of the trained technician.

Given this co-operation, I cannot see why preliminary training could not be undertaken now. We expect that our facilities will be of sufficiently high standard in the very near future to engage in this sort of training.

With regard to the reference in your editorial concerning the inadequacy of the Radio Serviceman's Examination, I heartily agree. I would like to point out, however, the importance of incentive, if men are required to study. The reason given by many of our boys who have reached University Entrance standard in maths and physics for not entering the radio industry is the lack of reward for study.

Yet it is amongst these very lads that I feel Mr. Slade will find the TV technicians he is looking for.

I am, of course, writing in a private capacity and my views are not necessarily those of the College.—Yours etc.,

R. WADDELL, B.Sc.,
Staff Member in Charge, Radio and Electronics,
Seddon Memorial Technical College,
Auckland.

TRADE WINDS

J. Hodge

Recently the annual golf match for the Cromwell Cup was played between H. W. Clarke (N.Z.) Ltd. and a team captained by Cromwell Dealer, Jack Hodge, the team consisting of Jack, Basil Clarkson, Colin Bristol, and Baillie Haworth, who were accompanied by Mrs. Hodge, Tony, and Richard.

This year the Wanganui team after some serious training were successful in gaining the cup from H. W. Clarke (N.Z.), Ltd., the holders, the results being as follows:—

J. Hodge beat E. Paulin, 1 up.
C. Bristol beat C. Eversleigh, 2 up.
B. Haworth beat K. Stephen, 3 and 2.
B. Clarkson lost to W. Clarke, 2 down.

The celebrations included a very successful dinner held at the Miramar Club House, hosts being Mr. and Mrs. W. B. Clarke and among the guests were Mrs. L. Crowe, Miss M. Pillinger (H. W. Clarke (N.Z.), Ltd.), and Mr. F. Hatton of Radio Ltd. (Purchasing Officer).

The festivities concluded with an evening held at the residence of Mr. and Mrs. K. W. Stephen.

* * *

Congratulations to Mr. B. W. Staff, of H. W. Clarke (N.Z.), Ltd. on his marriage last month; we suppose he is not spending many weekends away from Auckland now and his golf is bound to suffer.

* * *

In August, Wellington was invaded by a sales team of H. W. Clarke (N.Z.), Ltd., the occasion being a sales conference. B. W. Staff and L. A. Borthwick from Auckland, B. C. Clarkson from Mid-North, E. A. Paulin, Wellington, and W. K. Whelan from Christchurch were all there to pay their respects to new Sales Manager K. W. Stephen. Looks like an all-out sales drive on radio for the spring offensive.

* * *

Les Hurrell, after fourteen years wioth Radio Corporation (N.Z.) Ltd., in charge of special equipment and distribution, has gone back to business on his own account and is specializing in audio equipment and special forms of electronic apparatus. His address is L. W. Hurrell, Ltd., 173 Taranaki Street, Wellington, C.3. Telephone 242-850.

* * *

Wiseman Electric Co., Ltd., have been appointed Wellington's sole distributors and stockists of Hy-Line coils and inductances.

* * *

Miles Nelson, Ltd., have now established a branch at Athens Street, Miramar, Wellington, under the management of Des Taylor. Full stocks are now carried there and the telephone number is 16-127, and P.O. Box 1955.

* * *

Ray Elsom, at one time of Wellington, is superintendent of the warehouse at Miles Nelson, Ltd., Auckland.

* * *

Messrs. W. S. Green and Co., Ltd., Wellington, have been appointed sole New Zealand agents for AGA Record Changers.

* * *

Amalgamated Wireless (A'asia) Ltd., have received instructions to undertake the provision of special radio

AUCKLAND PROVINCIAL RADIO TRADERS' FEDERATION

At a well-attended Annual Meeting on 6th August, the following officers were elected for the ensuing year: President, Mr. S. Christie; Vice-Presidents, Messrs. C. R. Peoples and W. J. Murphy; Executive Members, Messrs. W. Hunter, M.C.L., Rhodes, and D. Green. Representative, Chamber of Commerce, also Apprenticeship Committee, Mr. S. Christie; S.M.T. Advisory and Election Committee, Mr. Orbell; Conference Delegates, to be fixed by the Executive.

Mr. H. J. Barr, retiring president, presented a full detailed report of the past year's activities. The Federation President, Mr. J. Fairclough, gave an address covering the work of the Federation's Executive.

Owing to lack of space in this issue we regret having to leave over more detailed account of this meeting until next month.

* * *

Bradley's Electrical Co., Ltd., announce the opening of a branch in Auckland at 27 Wyndham Street, under the management of John Boag, who has been with the Wellington branch for the past ten years.

* * *

One of the features of the Swan Electric Company Ltd.'s expansion programme—which we note is still proceeding apace—is the centralization in Auckland of the control of all the company's stocks, and Mr. Norman Chiswell, well known to all members of the radio trade has been transferred from his position as manager of Dunedin branch to take control of all stocks in the Swan Electric's Head Office in Auckland. Mr. Ken Bassett, formerly of Swan Electric, Christchurch, has been appointed Dunedin manager.

* * *

In order to maintain a closer liaison with their English and Continental principals, Charles Begg and Co., Ltd., have appointed Mr. C. A. Rendle as their overseas Advisory Director and he will be domiciled in the United Kingdom. His activities will embrace not only Beggs, but their wholesale and manufacturing subsidiaries.

Mr. Rendle has a wide circle of business friends in the radio and electrical trade throughout New Zealand and is best known as a director of Beggs and manager of Wellington branch.

A past President of the Wellington Radio Traders' Association, he has always displayed keen interest in matters affecting the trade. We wish them a pleasant voyage and trust that Mr. and Mrs. Rendle's stay in the Old Country will be a pleasant one.

Chief Engineer of Rola Co. (Aust.) Pty. Ltd. Visits New Zealand

Visiting New Zealand in August was Dr. F. Levi, Chief Engineer to the Rola Co. (Aust.) Pty., Ltd., well known as the manufacturers in Australia of Rola loudspeakers and winding wires.

Dr. Levi is a Doctor of Engineering of the Genoa University, and has been with the Rola Company since 1943, after having emigrated to Australia in early 1940. In a recent interview, he outlined some of the difficulties confronting speaker manufacturers the world over, and gave *Radio and Electronics* some very interesting information about the steps that were being taken to overcome the worst of these, namely, the world shortage of cobalt. Cobalt is one of the rarer of the non-precious metals, and large quantities of it are used in the manufacture of special steels. Notable among these are the modern alloys that have been developed for making permanent magnets, so that the speaker industry everywhere has been particularly hard hit by the shortage, which is due not only to the production of special steels for the rearmament programmes in both Britain and the United States, but also by stockpiling in the latter country. Speaker manufacturers have had their allocations of cobalt very drastically reduced, leaving them two alternatives—one to reduce the production of speakers in proportion, and the other to re-design the speakers so as to retain as nearly as possible the same cost—for cobalt has doubled in price—and efficiency, while reducing the cobalt content to a degree which will allow production to be kept up to pre-shortage quantities.

Fortunately, Dr. Levi said, the latter course has been possible, partly by re-designing the magnetic circuit for much higher efficiency (and therefore for much smaller magnetic leakage) and partly by devising new manufacturing techniques. In this respect, the Rola Company is at a considerable advantage in that their Australian factory makes its own magnets, from scratch, as it were, so that there is no question of having to employ already fabricated magnets. The new line of speakers should be no more expensive than the older type, which used more cobalt, and will make more efficient use of the magnet material. A useful feature of their extremely small external field is that that will be ideal for incorporation in TV receivers, where stray fields from the speaker often causes difficulty in speaker location so as to avoid interference with the cathode ray tube and consequent distortion of the picture.

In line with the efforts elsewhere to conserve cobalt, the Swan Electric Company, who manufacture Rola speakers in New Zealand, are tooling up for manufacture of the new type speakers. This is quite a difficult and costly undertaking, and it is in connection with this that Dr. Levi is visiting New Zealand.

In order to combine a little pleasure with business, Dr. Levi, who is a keen alpinist, is making good use of his opportunity to visit some of our vaunted South Island skiing grounds.

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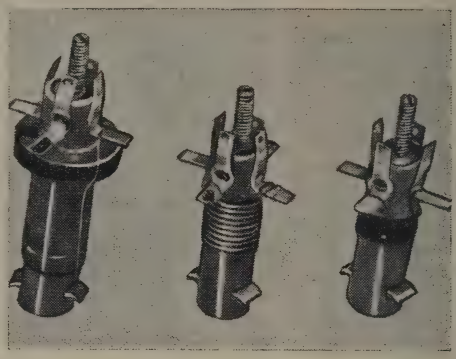

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THE N.Z.E.I.

NEWS LETTER

ANNUAL GENERAL MEETING

The Annual General Meeting of the Institute was held in the Air Department Building, Wellington, on Thursday, 9th August, 1951, at 5.30 p.m., the President, Mr. W. L. Harrison, being in the chair.

The Annual Report and Statement of Accounts were taken as read, and were confirmed with one slight amendment. It was agreed that further publicity should be given the Annual Report by circulation to interested organizations, and the meeting closed at 7 p.m. after a vote of thanks to the chair.

SUBSCRIPTIONS

Members are advised that the discount period for subscriptions has now expired, and Council would appreciate members renewing their subscriptions promptly, as if this is not done it will not be possible to continue sending "Radio and Electronics" to unfinancial members.

BRANCH NEWS

Wellington:

The August meeting of the Wellington Branch was held on 9th August, immediately following the Institute Annual General Meeting, and took the form of a film evening. The Committee has this year succeeded in arranging a full programme for the year, well in advance, and will shortly be sending to Wellington members a meeting card, showing the dates of all meetings for the ensuing year, and the subjects of the lectures to be given. It is intended to wind up the year's activities with a social evening, which will take the form of a conversazione, at which interesting electronic apparatus of many kinds will be demonstrated; the Committee is working on several schemes for amusing or novel displays that it is hoped Branch members will be able to build for use at the display.

Christchurch:

A very interesting meeting was held at Station 3YA on 30th July, 1951, when members heard an address by Mr. S. P. Willis on gramophone pick-ups. A manuscript has been forwarded to the Dominion Secretary, and it is intended to publish the text of Mr. Willis's address in the next issue of *Radio and Electronics*. Unfortunately, the script arrived too late for inclusion in this issue.

Since there is no Branch news from Dunedin or Auckland, we are printing below the second instalment of the B.B.C. booklet describing the British Television Service.

THE B.B.C. TELEVISION SERVICE

Part II.—A Technical Description

THE GENERAL PROBLEM

The transmission of television pictures is closely allied to the broadcasting of sound, but there are certain fundamental differences in technique. In order to appreciate the points of divergence, it is worth while considering the differences that exist between the two senses to which these arts make their respective appeal.

The sense of hearing to which sound broadcasting is directed has certain characteristics that can be appreciated by a brief examination of the properties of the ear. The ear may be said to be essentially a single-channel device, havinb but one eardrum; consequently, when several sounds strike it simultaneously, it receives them as a mixture. Hence, it is clear that any number of simultaneous sounds will resolve themselves into a single pressure wave representing a mixture of them all, which may be picked up and converted into an electrical waveform by a single microphone. The resulting waveform, however complex,, can be passed through a single amplifier and broadcast from a single transmitter.

The sense of sight to which television makes its appeal, works on an entirely different principle, and in order to understand the problems involved it is necessary to consider the action of the eye itself. An image of the scene being observed is cast by the lens, or cornea, on to the light-sensitive plate, or retina, at the back of the eye. The retina consists of a multitude of tiny elements, each separate and distinct from its fellows. There are some millions of these elements in the human eye, and each one is separately connected to the brain by an individual fibre in the optic nerve.

The eye is, evidently, a complex organ, and exercises keen discrimination, picking out minute details of the scene before it, and conveying a perception of each detail separately and simultaneously to the brain. It does not mix the details up, otherwise the viewer would perceive only an unintelligible blur.

In a television system, therefore, it would be useless to send a mixture of detail. Instead, all the details of a scene must be transmitted separately, though almost simultaneously, and to present a received picture of good definition something approaching a quarter of a million separate details must be transmitted. Happily, there exists a device known as the photo-electric cell, which reacts to light in the same manner as the microphone does to sound, and behaves in a manner that is analogous to one of the elements of the retina. All television systems are based upon its use, but to send simultaneously a quarter of a million details would necessitate a quarter of a million photo-cells, a quarter of a million radio transmitters, and as many receivers at the other end. As this is clearly impossible, an expedient has to be adopted to bring the transmission within the bounds of possibility. The expedient that is adopted

is the process known as "scanning," which consists of dissecting the picture into many minute pieces, like the pieces of a jig-saw puzzle, the details in each piece being sent out separately, then reassembled at the receiver so quickly that the eye is deceived into believing that it sees the whole picture simultaneously.

This process may be compared with the dictation of a book over the telephone. Even if it were possible to pronounce all the words on a page simultaneously, little information would be conveyed, and in consequence it is necessary to dictate word by word, line by line, and page by page. In the process of scanning, the picture to be transmitted is divided into a great many horizontal lines, the detail that occurs along each line being dictated by the scanning apparatus and faithfully transcribed by the receiver. The scanner also informs the receiver when to start each new line and each new page by means of "synchronizing signals."

If successive pictures are built up rapidly enough, the phenomenon called "persistence of vision" conceals from the brain the fact that the eye is being presented with separate pictures. The cinematograph, too, relies upon this principle to create the illusion of continuous movement. Clearly, sufficient frames must be transmitted each second to produce the desired illusion and to avoid the impression of flicker.

The television standards adopted in the United Kingdom are based upon the transmission of 25 complete pictures every second, composed of 405 lines. The number of lines determins the vertical definition of the picture. To secure a satisfying picture, the apparatus at the transmitting and receiving ends must be capable of dealing with the same degree of detail along the line and this standard of horizontal definition requires that frequencies up to about 2.75 megacycles per second should be effectively transmitted. These standards have been found to produce the best compromise between picture quality and cost of equipment. The presentation of 25 pictures per second is, however, not in itself sufficient to avoid flicker; this is done by what is called "interlaced" scanning. Instead of scanning every line in order from the top of the picture to the bottom, a coarser pattern of "frame" corresponding to the odd-numbered lines is scanned first, and this is followed by the scanning of all the even-numbered lines. Each pair of frames meshes together to form a complete picture, and since the frames are presented at the rate of 50 per second, there is no noticeable flicker. This is achieved without materially increasing the technical difficulties of transmission.

(To be continued.)

CLASSIFIED ADVERTISEMENTS

FOR SALE.—Hallicrafters S.52. Seven valves. Range 540 kc/sec–44 mc/sec. Convertible from present 110v. D.C. £100 or offer. Reply 21 Antico Street, Wellington, E.2.

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A. P. Hosking on TV

(Continued from Page 29.)

is a sure vindication that our policy of the second and third set in the home is 100 per cent. sound, and that if we are not enjoying the benefit of these sales then it is a sure reflection on our merchandising energies.

"Returning for a moment to the subject of the supposed impact of TV upon sound broadcast sales, I should not like anyone to imagine that the enormous increase in sound broadcast receiver production during the TV years has had any depressing effect on television sales, for this is not the case—contrarywise, the two have been complementary, one to the other, a fact which becomes glaringly apparent after studying the statement made in January, 1950, by General Sarnoff, chairman of directors of R.C.A., whose reputation for sanguine forecast is only too well known. He said that he anticipated there would be 20 million TV sets in operation by the close of 1954. Now let us correlate this forecast to the actual number of TV sets in operation one year later and we find that there are already over 12 million, and at the present production rate of 800,000 per month, it seems more likely that the General's 1954 target of 20 million will be reached by the end of 1951—three years ahead of the most sanguine forecast—unless material supply difficulties drastically limit production.

"With these facts in mind, I feel sure you must agree that our only concern should be how best to capitalize the widening field which today offers for sound broadcast receivers, leaving the problem of TV to take care of itself when it arrives, remembering always that concurrently with its introduction there will be receivers ready and waiting for you to satisfy public demands.

ADVICE FOR TRAIN TRAVELLERS

Check Luggage the Previous Day

Attend to the checking of your luggage the day before you travel, particularly when it is to go to a station in the other Island. You're then relieved of luggage-worry and can be sure your belongings will be ready for delivery when you arrive at your destination station. Address each piece of luggage clearly—BLOCK letters on a white label—and remove or obliterate all old addresses and destination labels. Your name and address also should be inside each package.

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Sole New Zealand Agents:

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"T" Attenuators

(Continued from Page 22.)

December, 1949, and January, 1951, issues of this magazine. Only two 20 db. sections were used, with an input of 10 volts, so that the 0–10 calibration of the potentiometer calibration points of 0–10v., 0–1, and 0–100mv. Thus, with only two 20 db. sections, the smallest calibrated point is 10 millivolts. For all except work with very low level microphones, this will enable audio amplifiers to be tested wtih known input voltages of the same order as they will be called upon to handle in practice.

(To be Continued.)

Philips Experimenter

(Continued from Page 32.)

used as a cross check in order to avoid the possibility of wrong harmonic beats being chosen, thus giving a wrong answer for the frequency coverage. However, if the same parts are used as in the original, and if the coils are wound to our specification, the frequency ranges will be close enough to the ones in the table to preclude this possibility.

Publications Received

The following trade and other publications have been received from the sources indicated and interested persons are invited to inspect them at our office.

"Theory and Application of Industrial Electronics," by John M. Cage; from McGraw Hill, International Book Division.
"Understanding Radio," (second edition), by Herbert M. Watson, Herbert E. Welch, and George S. Eby; McGraw Hill, International Book Division.
"Dial," Vol. 8, No. 1, I.G.E. (U.S.A.); National Electrical and Engineering Co., Ltd.
Booklets: "Story of Ultimate" and "On the Air," Radio (1936) Ltd.
Booklet: General Business Conditions in Brazil and the Argentine, Philco International Corporation.
"Philco World," Vol. 4, No. 2; Philco International Corporation.
"Radiotronics," May 1951; A.W.V., Sydney.
Brochure "Specialty Jack Trailer System"; Materials Handling Equipment Co., Ltd.
Cressall Potentiometers; Bradley Electrical Co., Ltd.
Belling-Lee Ltd., Catalogue of Components; Turnbull and Jones, Ltd.
T.C.C. Catalogue, Condensers, etc; Turnbull and Jones, Ltd.
"Connoisseur" Products Brochure; Turnbull and Jones, Ltd.
"Q Max" Catalogue; Turnbull and Jones, Ltd.
"Sylvania News," May 1951; G. A. Wooller and Co., Ltd.
From the Radio Industry Council, London, England—
Specification No. RIC/133 Capacitors, Fixed, Ceramic, Dielectric Grade 1.
Specification No. RIC/134 Capacitors, Fixed, Electrolytic.
Specification No. RIC/137 Capacitors, Fixed, Mica Dielectric Metallized.
Specification No. RIC/1000/C Standard Colour Coding for Connections in Radio and Electronic Equipment (other than Domestic Radio and Television).
Third Section only of the following specifications, which with Section 1 and 2 (already received by *R. and E.*) make these four sections complete:
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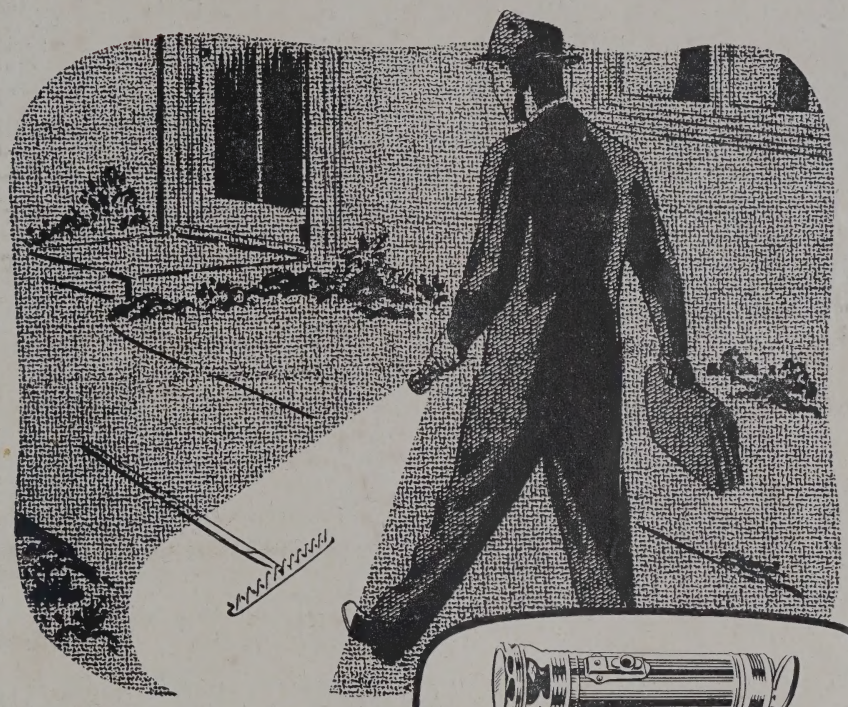

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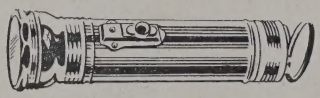

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